ACCEPTING THE CHALLENGE:
FACTORS THAT CONTRIBUTE TO IMPROVING
DEGREE COMPLETION RATES OF HISPANIC AND AFRICAN AMERICAN
STEM MAJORS

by

DAWN N. THOMAS

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ACCEPTING THE STEM CHALLENGE:

FACTORS THAT CONTRIBUTE TO IMPROVING THE DEGREE COMPLETION RATES OF HISPANIC AND AFRICAN AMERICAN STEM MAJORS

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One of my earliest memories of my father was watching him work three jobs so he could provide for a family of seven. During the week, he left the house before the sun cracked the sky to work a full day at his first job several cities over. In order for our family to work, I had to live with my great-grandmother during the week until I was 5 years old. Almost daily he would visit with me and allow me to go to work with him at his second job as a janitor at a nursery school. I thought I was going along just to get snacks, but I later found out it was the only way he could see me during the week. I was only three. Every evening after taking me back to my great-grandmother’s house my father would go home, eat dinner, spend time with my siblings then go to work again until midnight. My mother worked the third shift so that we would always have a parent at home.

As I got older, dad no longer had to work three jobs, but I never forgot how he was never embarrassed about doing menial jobs for the betterment of the family. My parents only had a high school education but was fortunate to live in a time when doing a job well meant job security and advancement. They were wise enough to realize this would not last forever and instilled an expectation of academic excellence inside each of their children. Our only job was to do well in school.

I dedicate my dissertation to Herman and Anna Belle Holman, the hardest working, selfless, fun-loving, family-oriented people who birthed the love of learning
inside of me. I only wish that the two of you were here to see the fruit of your years of
sacrifice and labor. I am extremely grateful for all you have done. I love you mom and
dad!
ACKNOWLEDGMENTS

There is no way possible I could have gotten through this dissertation without God. I am grateful for the morsels of encouragement, strength, support, love and hope that was continuously showered upon me through this journey. You truly know the plans that You have for me, they are plans to prosper me and not to harm me, plans to give me hope and a future (Jer. 29:11). Thank you, Lord, for being You in me.

I want to thank and acknowledge my husband, Paul for his constant support and love through this sometimes-arduous journey. Thank you for giving me the freedom to run away from home so that I can make strides on my dissertation while you hold down the fort. I am grateful for the 30 years of sacrifice and fun we’ve shared together. To our kids, Paul II, Ana, and Aja, thank you for handling this Ph.D. process like the valuable gems that you are. I appreciate you all for always being my cheerleaders throughout. I pray that God will do great things in and through you all and that the world will be changed through your endeavors.

To my wonderful dissertation committee, Dr. Olivia Boggs, dissertation chair, Dr. Joseph Balloun, methodologist and Dr. Kevin Jenkins, reader, thank you for hanging in there with me. Thank you for the many hours of guidance, support and encouragement that you selflessly offered. To Dr. Balloun, thank you for sharing that great mathematical mind with me, I appreciate the emails, phone calls and meetings. To Dr. Boggs, my limited vocabulary cannot even form enough words to thank you for the love, support,
and understanding that you have demonstrated towards me and my family. Thank you for the wealth of wisdom that you shared throughout the journey, I was listening.

To my faithful prayer group—Celeste Crowner, Regina Daniels, Monique Davis, Cathy Hudson, Rhonda Jackson, Sharon Jay, Monique Logan, Phyllis Lott, Sharyn Shields, Garnette Thomas, and Jan Toles—all I can say is wow! The effectual fervent prayer of a righteous “wo”man availeth much (James 5:16)! Thank you all for covering me and my family throughout the years. I am glad to know that you all are just one text away.

Finally, to my cohort 8 (GREAT) classmates. Thank you for the lifelong friendships that have been established through this journey. I am especially honored to have Drs. Lopez and Whatley in my corner. Many days I’ve had to stand on your shoulders for strength and encouragement and you never dropped me!
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ABSTRACT

DAWN N. THOMAS
ACCEPTING THE STEM CHALLENGE: FACTORS THAT CONTRIBUTE TO IMPROVING THE DEGREE COMPLETION RATES OF HISPANIC AND AFRICAN AMERICAN STEM MAJORS
Under the direction of OLIVIA BOGGS, Ed.D.

Science, technology, engineering, and mathematics (STEM) disciplines are imperative for the advancement of critical knowledge, assurance of national security, strengthening of community infrastructures, and the physical and psychological well-being of individuals and families. The purpose of the research was to determine if differences existed in institutional characteristics which attributed to improvements in the degree completion rates of Hispanic and African American STEM majors. The study centered on the problem of the underrepresentation of minority students completing degrees in STEM.

This quantitative study used one-way analysis of variance (ANOVA) and mixed-method ANOVA to test archival data. Tests of within-subjects and between subjects were used for each research question to demonstrate if there was a statistically significant difference between Hispanic American, African American and White STEM students. The researcher selected 39 Research I STEM institutions in the United States where at least one-third of conferred bachelor’s degrees were awarded in STEM fields and had at least 70% overall six-year undergraduate graduation rates for all populations. The
researcher examined precollege achievements, financial opportunities afforded to minorities, minority recruitment, institutional minority programs, summer bridge programs, and institutional plans of action. The IPEDS and institutional websites provided data for this study. The results conclude a gap exists among the degree completion rates of Hispanic and African American STEM students and White STEM students. The researcher found statistical evidence to suggest minority recruitment programs and implemented institutional plans of action for minority improvement contributed to increased degree attainment rates for minority STEM majors at the selected institutions.

Future research could examine if the variability can be related to the amount of interaction between minority STEM faculty and minority STEM students; institutional partnerships with industrial leaders designed for financing minority STEM student’s education; mentorship programs with minority alumni and/or minorities employed in STEM professions; and earlier exposure to the STEM pipeline beginning with elementary school programs. These recommendations will allow trackable data to be analyzed and may lead to more statistically significant results.
CHAPTER 1
INTRODUCTION

Science, technology, engineering, and mathematics (STEM) disciplines are imperative for the advancement of critical knowledge, assurance of national security, strengthening of community infrastructures, and the physical and psychological well-being of individuals and families (Byhee, 2010; Fairweather, 2008; Wang, 2013). Furthermore, STEM occupations provide some of the most promising career options, as evidenced by a growth rate of 17%, compared to 9.8% for all other disciplines (U.S. Department of Commerce, 2011). In 2009, the U.S. Department of Labor (2011) determined that eight of the ten most wanted employees were those with degrees in STEM fields.

This study targeted the increasing importance of STEM careers and the dearth of minorities completing degrees in these highly competitive disciplines (Museus, Palmer, Davis, & Maramba, 2011). Despite advances in the degree completion rates of minority STEM majors (American Institutes for Research [AIR], 2013), national data still indicate a disproportionate amount of STEM degree attainment for Hispanic American and African American students compared to White and Asian students (DePass & Chubin, 2009; Estrada et al., 2016; Estrada, Hernandez, & Shultz, 2018; National Center for Education Statistics [NCES], 2005). The chapter begins with a historical overview, followed by background of the problem, purpose of the study, research questions,
theoretical foundation, study significance, procedures, delimitations and limitations, and key definitions.

Historical Antecedents

*We hold these truths to be self-evident, that all men are created equal; that they are endowed by their Creator with certain unalienable Rights; that among these are Life, Liberty and the pursuit of Happiness*  
(T. Jefferson, 1776, Declaration of Independence, para. 1)

The indentured servitude of the first Africans brought to the United States in 1619 resulted in over three centuries of persecution, loss of human rights, and denial of a quality education (Ballagh, 1902; Franklin, 1947; Woodson, 1915). The avowal found in the Declaration of Independence that “all men are created equal” (Jefferson, 1776, para. 1) was not inclusive of African slaves. Thomas Jefferson (1787) noted, “The blacks, whether originally a distinct race, or made distinct by time and circumstances, are inferior to the whites in the endowments both of body and mind” (p. 166). Although modification of the Constitution in the form of the 13th, 14th, and 15th amendments resulted in abolishment of slavery, granting of citizenship for Blacks, and allowance of Black men to vote, Blacks struggled to experience the same rights as Whites (Litwack, 2010; Woodward, 1955). Jim Crow laws (Wormser, 2003) and de jure racial segregation ensured that Blacks continued to experience denial of full freedom and citizenship (Hansan, 2011).

Historically, many Hispanic youth were systematically assigned to segregated schools of parallel quality as their African American peers (Contreras & Valverde, 1994).
As with African Americans, challenges for improving the quality of education for Hispanics rested on the nation’s judicial system. Whereas African American students were isolated due to the color of their skin, segregation of Mexican American students was often based on having Spanish-surnames (Abramyan & Alexander, 2016; Macia, 2016) and incidents of Hispanophobia (Juarez, 2016; Jurado, 2008). Documented resistance to inclusion of Hispanics dates back to the 1930 Texas case of Independent School District (ISD) v. Salvatierra. The Del Rio ISD was charged with isolating Mexican American students primarily because of their ethnicity. The ISD won this case by contending that Mexican American students exhibited language deficiencies that justified separate schooling. The fight continued with Mendez v. Westminster School District, a federal class action 1946 suit. According to Valencia (2005), Méndez v. Westminster School District was based on integration theory, which cited the detrimental effects of segregation on Mexican American students. The United States Court of Appeals for the Ninth Circuit, in an en banc (unanimous from the full court) decision, held that segregation of Mexican Americans violated the 14th amendment. Mendez became the first ruling in the United States in favor of desegregation (Valencia, 2005).

Mexican Americans in the southern regions of the United States continued to fight for equal opportunities. The struggle to receive equal educational treatment for Mexican Americans in Texas was an almost insurmountable feat due to the enormous population of residents in the state with Spanish-surnames. In 1948, Delgado v. Bastrop Independent School District forbade segregation of Mexican Americans and instructed the district to offer separate classes for students not proficient in English to be housed on
the same campus as Whites. Language deficiencies could no longer be a factor for segregating Mexican American students in public schools (Allsup, 2010b).

Not until *Brown v. Board of Education of Topeka* was de jure segregation in public education deemed unconstitutional by the U.S. Supreme Court (Smithsonian National Museum of American History, n.d.d). This unanimous ruling was based on the consolidation of five parallel cases from South Carolina, Virginia, and Delaware that challenged the legality of government-sponsored segregation in public education and other public facilities. The defense team consisted of six attorneys from the NAACP Legal Defense Fund, led by Chief Council Thurgood Marshall, who argued that de jure segregation violated the 14th Amendment Equal Protection Clause, resulting in irreparable disparities in the public education provided to Blacks and Whites (Smithsonian National Museum of American History, n.d.d). In writing his opinion about this landmark decision, Chief Justice Earle Warren (as cited in Smithsonian National Museum of American History, n.d.d) noted,

> Segregation of white and colored children in public schools has a detrimental effect upon the colored children. The impact is greater when it has the sanction of the law, for the policy of separating the races is usually interpreted as denoting the inferiority of the Negro group. . . . Any language in contrary to this finding is rejected. We conclude that in the field of public education the doctrine of “separate but equal” has no place. Separate educational facilities are inherently unequal. (para. 3)
The Court’s unanimous decision in *Brown v. Board of Education* opened doors for numerous initiatives and strategies geared to better the quality of education for people of color. This landmark decision served as a major catalyst for equalizing the academic experiences for African Americans, as well as people of other ethnicities and racial groups, including Hispanics (Contreras & Valverde, 1994).

The Supreme Court’s ruling in *Brown v. Board of Education* presented new challenges for public education in the United States. The Court’s decision not only required a devised plan to desegregate public school systems with strategies, but produced ramifications that spanned for decades such as busing and reallocation of school funding, Title I programs, magnet schools, in addition to bilingual and multicultural education (Contreras & Valverde, 1994). The nation’s newly devised plan to desegregate public school systems had to be administered “with all deliberate speed” (Smithsonian National Museum of American History, n.d.e, para. 1).

To help guarantee equality during the desegregation phase, new laws were enacted to establish *race-conscious* policies to encourage minority opportunities in employment, schooling, and governmental hiring (Dale, 2005). The legislative framework for such policies, later called affirmative action, stemmed from the Civil Rights Act of 1964. In regards to higher education, most selective institutions in the United States used the guidelines established by affirmative action to enhance enrollment rates for African Americans and Hispanics (Bowen & Bok, 1998). Affirmative action policies offered many advantages for underrepresented students in higher education (Chun & Evans, 2015). To boost access to higher education institutions in the nation,
colleges had a purposeful plan to recruit underrepresented students and utilize race-conscious admissions policies. To ensure affordability, many schools offered need-based financial assistance to help to close any financial gap that may have existed. To encourage persistence and completion, colleges and universities offered on-campus services, such as tutoring and mentoring programs (American Association of University Professors [AAUP], 2000). Prior to the implementation of affirmative action programs, a sparse number of American students of color attended predominantly White colleges in the United States. Affirmative action programs more than tripled the number of college applications from minorities (National Conference of State Legislature [NCSL], 2014), and more than 20% of undergraduates who enrolled in four-year institutions were students of color (AAUP, 2000).

Following Texas’ decision to abolish affirmative action, Rice University, one of the state’s highest rated colleges and one of the nation’s highest-ranking engineering institutions, experienced a 46% drop in enrollment for African American freshmen students and a 22% decline in enrollment for Hispanic students (Card & Krueger, 2005). Similarly, minority admissions dropped by 61% at the University of California at Berkeley and 36% at UCLA after California became a race-neutral admission state and abolished its affirmative action programs (Brown & Hirschman, 2006).

In 1997, two denied applicants challenged the University of Michigan’s affirmative action admission policy, leading to the class action lawsuit of Gratz v. Bollinger. The University of Michigan systematically awarded points to underrepresented undergraduate applicants (Devins, 2003). In a 6-3 ruling, the U. S.
Supreme Court ruled that it was unconstitutional to award points to students solely because of their race for undergraduate admissions because it was the functional equivalent of a quota system. Since there was not a narrowly tailored method of assigning the points for race, the U. S. Supreme Court found the university in violation of the 14th amendment’s Equal Protection Clause (NCSL, 2014). However, on the same day as the *Gratz v. Bollinger* ruling, the United States Supreme Court also made a decision in the *Grutter v. Bollinger* case, ruling in favor of race-conscious admissions at the University of Michigan Law School (Devins, 2003). The U. S. Supreme Court held that although the university used race as a factor for marginalized students, the admission process included many other factors and the use of the narrowly tailored method. The findings of these cases led the way for the restructuring of affirmative action programs in colleges and universities across the United States (Smithsonian National Museum of American History, n.d.a).

**Background of the Problem**

In his 2011 State of the Union Address, President Barack Obama stated, “We need to out-innovate, out-educate, and out-build the rest of the world” (para. 22). The following year, the *Engage to Excel* initiative was launched with the goal of producing one million additional qualified graduates prepared for science, technology, engineering, and mathematics (STEM) professions (President’s Council of Advisors on Science and Technology [PCAST], 2012). In order to address the perceived shortage of STEM professionals in the next decade, PCAST’s proposed “increasing the retention of STEM majors from 40% to 50% would generate three-quarters of the targeted one million
additional STEM degrees over the next decade” (p. 7), as well as continuously increase the production of STEM professionals by 34% annually.

The American Institutes for Research’s 2013 report stated for the last 10 years, Asians, Pacific Islanders, Hispanics, American Indians, and Alaskan Natives have shown a steady increase in the number of STEM degrees awarded; however, the number of STEM degrees awarded to African Americans has remained stagnant. From 1990 through 2009, there was an overall increase of conferred STEM degrees for all racial and ethnic groups in the United States. During this timeframe, the Asian culture more than doubled the total number of awarded STEM undergraduate degrees, while the Hispanic culture tripled the amount of its STEM undergraduate degrees, and the American Indian/Alaskan Native culture’s STEM degrees are growing at the fastest rate. However, the number of degrees conferred upon African Americans doubled between 1989 and 2004, leveled off in 2005, and have remained constant since that time (American Institutes for Research [AIR], 2013).

Landivar (2013) noted that Whites make up approximately 65% of the population and account for about 71% of the conferred STEM degrees; Asians make up approximately 5% of the population but represent 15% of STEM professionals; Hispanics represent approximately 14% of the population and have earned just 7% of the awarded STEM degrees; and African Americans comprise about 15% of the U.S. population, but only received 6% of all conferred STEM degrees. In order to meet the charge of producing one million more STEM professionals by 2020, the United States must rely on all segments of its population especially those who are underrepresented. Table 1 shows
the percentage of the U.S. population for each ethnic group and the percentage of undergraduate STEM degrees awarded in the United States. Specifically, the table provides comparisons between the percent of each ethnic group in the U.S. population in 2012 and the percent of each of these groups awarded STEM degrees in that year.

Table 1

*Ethnicity of STEM Degree Recipients Compared to Ethnicity of U.S. Population*

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<tr>
<td>Doubled</td>
<td>Asian</td>
<td>5.6</td>
<td>15.0</td>
</tr>
<tr>
<td>Greatest Increased</td>
<td>American Indian/Alaskan Native</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Steadily Increased</td>
<td>White</td>
<td>61.8</td>
<td>71.0</td>
</tr>
<tr>
<td>Tripled</td>
<td>Hispanic</td>
<td>17.6</td>
<td>7.0</td>
</tr>
<tr>
<td>No Change</td>
<td>African American</td>
<td>13.1</td>
<td>6.0</td>
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*Figure 1* displays the demographics representation in the STEM workers in the United States for 2011. The chart further compares the total workforce with those exclusively in STEM fields.
If this problem is not resolved, Hispanic and African American communities will continue to be negatively impacted. Hispanics and African Americans currently have the two lowest median household incomes of all races in the United States: $42,491 and $35,398 respectively (U.S. Census Bureau, 2012). In 2014, the official poverty rate was 14.8%, which represented 46.7 million Americans. The poverty threshold in 2014 was $28,960, comprised of 49.8% of the Hispanic and African American population (U.S. Census Bureau, 2015). Table 2 displays data derived from the U.S. Census Bureau report regarding the median household income and poverty rates for 4 of the 5 different ethnic groups in the United States.
Table 2

Median Household Incomes and Poverty Rates in the United States in 2014

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>% of U.S. Population</th>
<th>Median Household Income</th>
<th>% of People in Poverty</th>
<th>Number of People in Poverty</th>
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<tr>
<td>Asians</td>
<td>5.6%</td>
<td>$74,297</td>
<td>12.0%</td>
<td>2.1 million</td>
</tr>
<tr>
<td>Whites</td>
<td>61.8%</td>
<td>$60,256</td>
<td>10.1%</td>
<td>19.7 million</td>
</tr>
<tr>
<td>Hispanics</td>
<td>17.6%</td>
<td>$42,491</td>
<td>23.6%</td>
<td>13.1 million</td>
</tr>
<tr>
<td>African Americans</td>
<td>13.1%</td>
<td>$35,398</td>
<td>26.2%</td>
<td>10.8 million</td>
</tr>
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</table>

Both Hispanic and African American communities could benefit greatly if PCAST’s mandate is met. STEM professions are considered crucial vocations of the U.S. transformative economy that carries enormous consequences for long-term economic growth and personal welfare (Atkinson & Mayo, 2010). Atkinson and Mayo (2010) explained,

The purpose of driving STEM education is not principally to create economic opportunity for individuals; it’s to provide the “fuel” needed to power a science- and technology-driven U.S. economy. Without the right number and quality of STEM-educated Americans, the U.S. innovation economy will continue to falter, and with it, economic opportunity—not just for STEM grads, but for tens of millions of other Americans employed in industries enabled by American science and technology. (p. 7)

In the U.S. Census Bureau 2011 Analysis of American Communities Survey report, 13.3% of Whites and 7.5% of Hispanics earned more than $100,000 per year
compared to just 6.5% for African Americans. By 2043, the United States is projected to shift to a majority-minority nation; which means within the next 30 years individuals of color will outnumber Whites nationally (U.S. Census Bureau, 2011). Moreover, the predicted timeframe for children under the age of 18 to reach the majority-minority status could occur within the next four years (U.S. Census Bureau, 2013). Individuals of color in the United States (Black, Hispanic, and Native Indians) together contribute to only 13% of the STEM labor force and just 16% of all conferred undergraduate STEM degrees (U.S. Census Bureau, 2011) with limited contributions from African Americans (AIR, 2013). One reason to address this problem is STEM professions enable individuals to access the economic strength of the U.S. infrastructure. In the face of the U.S.’s last economic recession that ended in 2009, companies that specialized in high-tech, advanced manufacturing and medical fields have continued on solid economical footings and achieved growth despite bleak fiscal times (West, 2013).

Statement of the Problem

The research problem targeted by this study is the underrepresentation of Hispanic and African American students completing degrees in science, technology, engineering, and mathematics (STEM) disciplines (Brown et al., 2015; Hrabowski, 2015; Zambrana et al., 2015). The dearth of minorities involved in STEM careers is viewed as a weakness in national security (Kinslow, Jackson, Barrow, & Doss, 2015), a constraint to long-term economic growth in diverse communities (Gregory, 2015), and a deterrent to civic responsiveness (Garibay, 2015). However, if the graduation rates for Hispanic American and African American STEM majors mirrored those of Whites and Asians,
then the projected shortage of domestic STEM workers in the United States would be greatly reduced (PCAST, 2012). In turn, this would lead to long-term economic improvements in Hispanic and African American communities (Atkinson & Mayo, 2010; Gibbs, 2014); diverse pools of scientific talent resulting in greater scientific advancements (Gibbs, 2014), and the development of a “sense of belonging” and identity as scientists for underrepresented minorities (URMs) (Cohen & Garcia, 2008; Griffin, 2018).

Purpose of the Study

The purpose of this study was to determine if recruitment, retention, and degree completion of Hispanic and African American STEM majors varies by policies, strategies, platforms, and programs initiated at the 39 top-ranked Research I universities, which grant a large percentage of overall degrees in the STEM field in the United States.

Research Questions

The overarching research question aligns with Tinto and Pusser’s (2006) Institutional Action Model: Does the institution have a strategy for improving the degree completion rates for minority students? The following research questions guided this study:

1. Are there differences in the White, Hispanic, and African American degree completion rates among Research I STEM institutions?
2. If so, is the variability among completion rates related to students’ precollege achievements?
3. If so, is the variability among completion rates related to financial opportunities afforded to students?

4. If so, is the variability among completion rates related to minority recruitment programs?

5. If so, is the variability among completion rates related to institutional minority programs?

6. If so, is the variability among completion rates related to summer bridge programs for minority STEM majors?

7. If so, is the variability among completion rates related to the institution having a plan of action for improving graduation rates for African American and Hispanic American STEM majors?

Theoretical Framework

Vincent Tinto and Brian Pusser’s (2006) Model of Institutional Action served as the theoretical lens through which to view the problem of this study. Tinto (2012) posited that once a student is enrolled in a college or university, the college or university is obligated to have systems in place to help the student persist through to graduation. Tinto and Pusser (2006) asserted that colleges that fail to understand and implement safeguards ultimately create systems that lead to student failure. Tinto and Pusser’s theory is based on the disconnect between and among theory, research, and practice. For the purpose of this study, the researcher examined whether selective Research I STEM institutions’ practices align with the research and theory as outlined in the institutions’ strategic plans, mission statements, and vision statements.
To increase the retention and graduation rates, the college or university staff needs to start by self-examining its practices and developing processes within the institution to promote the necessary results. Tinto (2012) maintained that to improve student retention and graduation over a long timeframe, institutions must establish campus-wide efforts to stimulate student success. Tinto and Pusser’s (2006) model is based on institutions converging four conditions: (a) expectations, (b) support, (c) assessment and feedback, and (d) involvement.

The first condition for student success is expectations. The expectations set by the student partially drive the success of the student. These expectations are generally triggered by the myriad of actions set by the college or university, which include expectations placed on the student to perform at a certain level by both the institution and faculty members. According to Tinto (2012), the clarity, consistency, and level of expectations diametrically affect student success. High expectations tend to lead to student success, whereas low expectations tend to be a forerunner for failure.

The second condition for student success is support. Institutions cannot set high expectations for students without providing adequate support for them to achieve them. Without appropriate support—whether it is academic, social, or financial—the challenges to succeed in higher education for many students become overwhelming, and students fail to meet institutional expectations (Belcheir 2001; Filkins & Doyle 2002; Perna & Jones, 2013; Upcraft, Gardner, & Barefoot, 2004; Ward, Trautvetter, & Braskamp, 2005; Zhao & Kuh, 2004).
The third condition for student success is assessment and feedback. Colleges and universities that assess student performance and provide timely, constructive, and frequent feedback create an environment where students often succeed (Tinto, 2012). Assessment is essential to a student’s ability to acquire knowledge and is a formidable driver in determining what a student does and how he or she does it (Beaumont, O’Doherty, & Shannon, 2011). Feedback is a crucial component of assessment and is valued by students (Adamson & Webster, 2015).

The fourth and final condition is involvement. Tinto and associates argued that involvement or engagement is the most crucial condition for student success (Astin, 1984; Kuh et al. 2005; Kuh, Schuh, Whitt, & Associates, 1991; Tinto, 1975, 1993, 2012). A strong positive correlation exists between student success and student engagement with peers, staff, and faculty. The more a student is involved academically and social, the greater likelihood the student will succeed in college (Tinto, 2012).

When all four conditions are met, students are likely to persist in college. According to Tinto (2012), the absence of one condition weakens the effectiveness of the remaining three conditions. Students tend to succeed at institutions that have: (a) clearly communicated high expectations; (b) both academic and social support; (c) regular assessments and reception of constructive feedback in a timely manner; and (d) opportunities to actively engage in campus and classroom activities. Student success is not based on happenstance, but institutional staff must purposely develop “intentional, structured and systematic forms of action that involve faculty, student-affairs staff, and administrators alike” (Tinto, 2012, p. 9).
Significance of the Study

For the United States to remain competitive in the global marketplace, leaders in higher education must address the need to close the persisting gap among the different ethnic groups and improve diversity among STEM professionals. In addition to aiding in producing ample numbers of STEM professionals, diverse groups are generally more astute and resilient than homogeneous groups when innovation is a crucial goal, as it currently is in the competitive global economic environment of the United States (Page, 2007).

The findings from this study may be used to aid in fostering initiatives that cater specifically to the needs of Hispanic and African American student populations. This study may also add to the body of literature, providing data regarding Hispanic and African American STEM majors at four-year selective institutions. This new information about this demographic may provide avenues for improving degree completion rates.

Procedures

This study examined the impact of students’ precollege achievement, financial opportunities afforded to students, minority recruitment programs, summer bridge programs, institutional characteristics, and institutional minority programs on the degree completion rates of African American and Hispanic STEM majors at the 39 top-ranked Research I universities that grant the most STEM degrees in the United States. The researcher utilized quantitative methods since, according to Punch (2003), the heart of quantitative research emphasizes the relationship between variables. The researcher used both one-way analysis of variance (ANOVA) and mixed method ANOVA to test if there
were differences in the six-year graduation rates of White, Hispanic, and African American STEM majors at the selected institutions. Tests of within-subjects and between subjects were used for each research question to determine if there was a statistically significant difference between students’ precollege achievement, financial opportunities afforded to minorities, minority recruitment programs, summer bridge programs, institutional minority programs, institutional plans of action and the differences in degree completion rates of Hispanic and African American STEM majors at the selected institutions.

The researcher used the federal Integrated Postsecondary Education Data System (IPEDS) reports as the repository from which data were retrieved for questions 1 through 3. The researcher used the selected institutional websites to provide data to examine the policies, strategies, platforms, and programs institutions had in place to determine the role of institutional practices on high degree completion rates of minority STEM majors at the selected institutions. Once the data were collected, the researcher analyzed each question by race.

Delimitations and Limitations

Three study delimitations are recognized. First, the population was restricted to Hispanic and African American students formally enrolled at each of the institutions. The degree completion rates for both populations are disproportionate when compared to other ethnic groups. Second, the study examined four-year selective, Research I public institution in the United States. The researcher chose to examine institutions with similar entrance requirements and similar academic rigor. According to Chen and Soldner
(2013), there is a positive correlation between the selectivity rate of an institution and graduation rates. Lastly, the researcher observed graduation rates from 2004 to 2014 in order to examine two accreditation cycles.

One limitation for this study was the self-reporting of student participants regarding their race or ethnicity as nonHispanic, Hispanic, Caucasian, American Indian/Alaskan Native, Asian African American, or other on their admission documents. NonHispanic categories include White; Black or African American; American Indian or Alaskan Native; Native Hawaiian or other Pacific Islander; and other nonHispanic or Latino races. Hispanic participants may also identify with one of the other categories, such as Puerto Rican, Mexican, Cuban, or other Hispanic or Latino race. The selected institutions offered harsh penalties for knowingly presenting false or misleading information on institutional documents.

Definition of Terms

Terms used within the context of this study are described as follows:

*African American* or *Black* refers to a person having origins in any of the Black racial groups of Africa (Rastogi, Johnson, Hoeffel, & Drewery, 2011). The Black racial category includes people who marked the Black, African Am., or Negro checkbox on the census. It also includes respondents who reported entries such as African American; SubSaharan African entries, such as Kenyan and Nigerian; and Afro-Caribbean entries, such as Haitian and Jamaican.

*Hispanic* or *Latino* is a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race (Rastogi et al., 2011).
**Historically underrepresented students**, according to Sierra College (n.d.), “refers to racial and ethnic populations that are disproportionately represented in higher education” (para. 1) for “a ten-year or longer trend at a given school” (para. 1).

*Istitutional action* is the organization and allocation of resources by the institution to foster student engagement and ensure that students take advantage of the resources and opportunities that lead to student success (Kuh, Cruce, Shoup, & Kinzie, 2008).

**STEM (science, technology, engineering and mathematics)** refers to mathematics, physical sciences, biological/life sciences, engineering, engineering technologies, science technologies, and computer and information sciences, for the purpose of this study (National Science Foundation, 2014).

Successful outcomes, as described by the researcher in this study, pertains to the institutional actions that promote and increase the rates of STEM degree attainment for racial and ethnic groups historically underrepresented in higher education within a six-year period.

**Summary**

The number of qualified STEM professionals in the United States needs to increase to address the charge presented by PCAST (2012). The council identified several potential solutions to address the deficit of one million STEM professionals; one was to increase the STEM pool by 34% annually and the other was to increase the retention rate of STEM undergraduates from 40% to 50% (PCAST, 2012). Although the number of conferred STEM degrees for Hispanics in the United States has increased
slightly, the number awarded to African Americans from four-year institutions has remained constant for the last decade. African Americans earn only 6% of all STEM degrees conferred in the United States; Hispanics earn only 7% of the degrees (Landivar, 2013).

The purpose of this quantitative study was to address the research problem by examining whether selective, public Research I STEM institutions’ student characteristics, institutional characteristics, and institutional programs are predictors of high degree completion rates of African American and Hispanic STEM majors. The findings from this study may be used to aid in developing programs that cater specifically to the needs of Hispanic and African American STEM student populations. This study may also add to the body of literature, providing data regarding minority STEM majors at four-year selective, public Research I STEM institutions to address ways to improve the low domestic STEM degree attainment rates for Hispanics and African Americans.
CHAPTER 2
LITERATURE REVIEW

The purpose of this study was to address the dearth of Hispanic and African American STEM graduates by examining the implemented strategic plans, mission statements, and vision statements of selective, public Research I STEM institutions to determine whether the graduation outcomes for minority STEM students align with the institutional policies and practices. Chapter 1 presented a discussion of the variables included in the study and offered a theoretical framework for the presented research questions. The overarching research question presented by this study was: How do selective Research I STEM institutions foster successful outcomes for Hispanic and African American STEM majors? The review for this study is organized around the following major themes: (1) historical antecedents; (2) Model of Institutional Action theory; (3) current status of STEM education in the United States; (4) factors that contribute to STEM attrition; (5) benefits of diversity in STEM professions; and (6) summary of the review of literature.

History of STEM Education in the United States

Throughout its history, leaders of the United States have desired to lead the world in science and technology innovation. Dating back to the Revolutionary War, General George Washington desired to reduce the U.S.’s dependency on foreign scientists and artillerists. He, along with other soldiers and officials, urged the creation of an institution
dedicated solely to study the art of warfare. In 1802, the United States Military Academy at West Point was created for the purpose of instructing and preparing men in the philosophy and execution of military science (U.S. Military Academy, 2009). Innovators such as Thomas Edison and Henry Ford played a pivotal role in the Industrial Revolution, utilizing STEM principles to create some of the world’s most prolific inventions in history. However, most had limited formal education and few even attended college (Butz et al., 2004). The passing of the Morrill Act of 1862, which was responsible for the development of land grant universities in the United States, catapulted STEM education in higher educational institutions. In its infancy, the Morrill Act focused on agricultural training, but engineering-based training programs quickly formed (Butz et al., 2004).

The interest in STEM education transitioned from postsecondary education to the secondary level in 1904 with the establishment of Stuyvesant High School (Ranis, 2008) in New York. The purpose of establishing STEM secondary schools was to train individuals with specific technical skills to meet the economic, political, and educational needs of society (Ranis, 2008). After World War I, Brooklyn Technical High School (2013) was established in 1922 to address the need of preparing students for jobs that required greater technical skills with a heavy focus on math and science and to serve as a feeder school for students to enter into either college or a technical profession in industry. In 1938, the Bronx High School of Science opened to train students for additional study in the areas of mathematics and science.

In 1939, World War II began, and the United States officially announced its involvement in 1941. During WWII, scientists from across the globe invented and
implemented technologies such as the atomic bomb, various weaponry, synthetic rubber, and numerous land and sea vehicles for transportation (White, 2017). Toward the end of World War II, President Franklin Delano Roosevelt (1944) penned a letter to Dr. Vannevar Bush, Director of the United States Office for Scientific Research and Development (USOSRD), in which the president recognized that the nation and its allies must apply existing scientific knowledge to address the overriding technical problems existing in the war. Roosevelt posited that the information gathered, the methods used, and investigative experience developed by USOSRD along with thousands of university and private industry scientists should be utilized not only during wartime, but also during peacetime, for they would be vital to the United States’ welfare. On November 17th, 1944, President Roosevelt posed the following question:

Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war? (para. 9)

Dr. Vannevar Bush (1945) responded by informing President Roosevelt,

The responsibility for the creation of new scientific knowledge rests on that small body of men and women who understand the fundamental laws of nature and are skilled in the techniques of scientific research. While there will always be the rare individual who will rise to the top without benefit of formal education and training, he is the exception and even he might make a more notable contribution if he had the benefit of the best education we have to offer. (p. 23.)
Dr. Bush requested an awakening of scientific talent within the country’s educational system to include not only secondary schools, but to also include colleges and universities in the government’s renewed focus on STEM education (Bush, 1945).

In 1957, the Soviet Union stunned the world by successfully launching Sputnik-1, earth’s first artificial satellite. The success of the launch, as well as mounting Cold War tensions between the United States and the Soviet Union, provided the justification for increased emphasis in science and technology, leading to substantial overall support for the improvement of STEM education in the United States (Stephens, 1998). In response to the Soviet Union’s success, U.S. President Dwight Eisenhower quickly established a shared, coordinated, and continued effort to engage and instruct the best and brightest individuals, who consequently formed a new group of leaders and forerunners in science and engineering (National Science Board [NSB], 2010). President Kennedy furthered Eisenhower’s platform in his 1962 Moon Speech at Rice University when he vowed to situate the United States in a preeminent position of leadership in science. He recognized that educational institutions focused on technology would benefit from the new knowledge obtained from studying the universe, and this new knowledge would greatly impact the nation’s economy by creating a large number of new businesses and adding tens of thousands of newly employed workers to the workforce industry (Kennedy, 1962).

For the next 50 years, the United States continued to focus on developing STEM professionals to stay viable and competitive in a prospering global economy (Friedman, 2005). In August of 2007, President George W. Bush signed the America Creating
Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act of 2007. In January of 2007, President Obama signed into law the America COMPETES Reauthorization Act of 2010. The goal of America COMPETES Act of 2007 was to amplify STEM research resources and to produce a viable national education pipeline of STEM professionals to sustain United States’ competitive edge in technology on the worldwide scene (Senate Committee on Commerce, Science, and Transportation, 2012). The reauthorization of the America COMPETES ACT honors the heart of the initial Act by increasing the emphasis on STEM education as a nationwide priority (Senate Committee on Commerce, Science, and Transportation, 2012).

Hill, Corbett, and St. Rose (2010) asserted that the country’s economy is highly dependent upon a population that possesses scientific and technical skills within STEM fields for economic growth. Donovan, Mateos, Osborne, and Bisaccio (2014) further noted that STEM education adds to economic growth by generating human capital. In President Obama’s 2011 State of the Union Address, he stated, “We need to out-innovate, out-educate, and out-build the rest of the world” (para. 21). The following year, President Obama’s team developed the Engage to Excel initiative with the goal of producing one million additional qualified graduates prepared for science, technology, engineering, and mathematics professions (President’s Council of Advisors on Science and Technology [PCAST], 2012). In October of 2015, President Obama signed the STEM Education Act of 2015, which consisted of three components: (a) expand opportunities for math and science teachers to obtain training and research through a
scholarship program from the National Science Foundation (NSF); (b) increase informal STEM education research at the NSF; and (3) distinctly include computer science within the definition of STEM education (H.R. 1020).

History of African American Education in the United States

By the authority vested in me as President by the Constitution and the laws of the United States of America, to restore the country to its role as the global leader in education, to strengthen the Nation by improving educational outcomes for African Americans of all ages, and to help ensure that all African Americans receive an education that properly prepares them for college, productive careers, and satisfying lives. (Obama, 2013, p. 1)

The educational plight of Africans and African Americans in the American Colonies and the United States has at times been extremely tumultuous. The original design of the first American colonial colleges was to educate White males (Duster, 2009). The only requirement for admission to Harvard College was the enrollee must be able to read Latin and Greek (Duster, 2009). In the early 1800s, particularly in the New England and mid-Atlantic states, the Quakers and several other religious groups founded schools for Blacks (Johnson & Watson, 2005). Some communities offered integrated public teaching, while others were segregated. The increasing strength of antislavery sentiments in sections of the North provoked several communities to implement policies to allow Blacks to attend public schools (Franklin, 1947; Frazier, 1949; Woodson, 1915). Free Blacks benefited from this movement and gained an education. During the 1820s, Blacks began to attend college, and in 1823, Alexander
Lucius Twilight was the first Black to earn a college degree in the United States. Blacks enrolled at Oberlin, Bowdoin, and other colleges well in advance of the Civil War (Franklin, 1947; Pifer, 1973).

The movement to educate Blacks in the South was not as progressive as in the North. Except for a few open-minded slave owners who felt it was their moral duty to teach reading and writing to their slaves, the social atmosphere in the South during the slavery period essentially prohibited educating Blacks (Johnson & Watson, 2005). The number of slave revolts headed by educated Blacks began to increase, causing southern legislatures to adopt laws making it illegal to educate any slave or free Black (Franklin, 1947; Funke, 1920).

In 1861, the United States engaged in a Civil War to resolve uncompromising disparities between free and slave states over the power of the federal government to forbid slavery in U.S. territories and to prevent states from succeeding from the United States to form an independent nation, the Confederate States of America (Library of Congress, n.d.). During this time period, President Lincoln signed into law the Morrill Act of 1862, which donated public lands to several states and territories for the purpose of developing colleges to educate students in the areas of agriculture and mechanical arts to assist the agricultural and mining segments of the nation. This act provided each state with 30,000 acres of government land for every affiliate in their Congressional delegation based on the 1860 census (Morrill Act, 1862). During the third year of the war, President Lincoln signed the Emancipation Proclamation declaring the freedom of all individuals
held as slaves (Library of Congress, n.d.). The Civil War between the North and South ended April 9, 1865.

During the Reconstruction period after the Civil War, Blacks made short-lived achievements in their social and political states (Johnson & Watson, 2005). With the passage of the 13th, 14th and 15th Amendments to the U. S. Constitution and the Civil Rights Act of 1866, Blacks experienced liberty and rights of citizenship alongside restraining legislation that endeavored to reconstruct prewar social relationships (Bond, 1934). The emancipated slaves eagerly took advantage of their newly found freedom, and education became a top priority (Woodson, 1915). Because of anti-literacy laws strictly enforced in southern state during slavery (Finkelman, 2006), approximately 95% of the Black population in the United States could not read or write (Winston, 1971). White Southerners vehemently opposed efforts to provide educational opportunities to Blacks, believing they were inherently inferior and by affording such opportunities, Blacks would attain a privilege exclusive to upper class Southerners. Such elevation, White Southerners believed, would give Blacks a standing higher than the majority of previous slave owners (Betchel, 1989).

Throughout the 30 years following the emancipation, with the aid of Christian churches from the North, Black colleges grew rapidly in the South. In 1890, a second Morrill Act passed, directed at former Confederate states. This revised act required each state to demonstrate that race was not a requirement for admission, as well as the allocation of a distinct land-grant establishment for persons of color (Lee & Keys, 2013). Although the act required federal funds to go to states that did not discriminate, it also
allowed states to operate *separate but equal facilities*. The number of Black institutions of higher education in the South increased, but developed mainly as trade schools. Seventeen historically Black land grant colleges were created under this act in previous Confederate states. Agricultural, mechanical, and industrial subjects were the primary focus, and only a few of these newly formed, public institutions offered college level courses and degrees (U.S. Department of Education [USDOE], 1991).

The creation of the additional Black institutions of higher learning drew attention to the vastly differing philosophies of two leading Black educators regarding how the freed slaves were to be educated. W.E.B. DuBois, a biracial northern-born free man, was not a proponent of Blacks becoming skilled tradesmen. He felt the only way for Blacks to advance was through leadership of the upper class, which would require Blacks to obtain a college education (DuBois, 1899). Conversely, Booker T. Washington, a former slave, believed in the agricultural and mechanical college model for Black institutions, for he was a proponent of Blacks focusing on manual labor and trades to achieve prosperity (Spivey, 1978). His views eased much of the fears of White southerners who opposed establishing Black colleges in the South, resulting in the agreement of many southern state leaders to fund vocational and trade education for Blacks (Franklin, 1947).

Although the Civil War had ended and the 13th, 14th and 15th Amendments were passed, segregation was still alive in the United States. The landmark United States Supreme Court’s 1896 decision in *Plessy v. Ferguson* held that it was constitutional under the Equal Protection Clause of the 14th Amendment for states to require racial segregation in public facilities, including education, under the provision of separate but
The impact of this decision caused Black colleges to concentrate on teacher training to provide instructors for the segregated schools (USDOE, 1991). Not until the U.S. Supreme Court’s 1954 *Brown v. Board of Education of Topeka* was the *Plessy v. Ferguson* decision repudiated. The Supreme Court’s decision ruled that de jure segregation violated the Equal Protection Clause of the 14th Amendment, and it was unconstitutional to segregate students in public schools due to the lack of equality among the separate facilities. However, this decision did not set clear guidelines and direction on how to end racial segregation in public schools, leading to the Supreme Court’s 1955 *Brown v. Board of Education’s* second decision charging states to desegregate “with all deliberate speed” Smithsonian National Museum of American History (n.d.e, para. 1).

Following the *Brown v. Board* decisions, the nation attempted to tackle discriminatory practices by creating a series of anti-discriminatory policies to stimulate institutional desegregation (Darity, 2013). During the peak of the Civil Rights movement in the United States, President Kennedy issued an Executive Order that used the phrase *affirmative action* for the first time (National Conference of State Legislatures [NCSL], 2014). Affirmative action is not based on a single law or policy; it stems from a series of Presidential Executive Orders: “Affirmative action policies are those in which an institution or organization actively engages in efforts to improve opportunities for historically excluded groups in American society. Affirmative action policies often focus on employment and education” (NCSL, 2014, para. 1).

President Kennedy’s Executive Order addressed discrimination in the workplace, federal contractors were to take “affirmative action to ensure that applicants are treated
equally without regard to race, color, religion, sex or national origin” (NCSL, 2014, para. 2). Civil rights activists believed that, although the order was moving in the correct direction, it did not address the entire scope of the many institutional spheres where racial prejudice was ever-present (Anderson, 1999).

Following President Kennedy’s Executive Order, Congress passed Title VI of the Civil Rights Act of 1964 to offer an instrument to ensure equality in obtaining federally sponsored programs and activities (USDOE, 1991). Title VI also protects persons from being discriminated for race, color, or national original in federally funded programs and activities. Passage of the Civil Rights Act of 1964 led to the establishment of the Office for Civil Rights, which in its infancy stage concentrated on the elimination of de jure segregation in public P-12 facilities in the southern and border states (USDOE, 1991). The following year, President Johnson issued Executive Order 11246, which called for firms with at least 50 employees or ones which receive at least $50,000 in government contracts to escalate minority presence in the workforce (USDOE, 1991).

In 1974, Congress passed the Equal Educational Opportunities Act, forbidding states from refusing educational opportunities based on their race, color, national origin, or sex (Kihuen, 2009). As affirmative action policies expanded across different forums, opposition grew and began to challenge such race-based policies legally. In 1978, Regents of University of California v. Bakke, the Supreme Court ruled that it is unconstitutional for a university to use racial quotas in its admissions process; however, it is constitutional for the school to use affirmative action to enroll additional underrepresented applicants in some situations (McBride, 2006). In 1995, the University
of California’s Board of Regents elected to eliminate race, ethnicity, religion, color, or national origin as a measure when considering individuals for admissions, hiring, or contracting in California’s higher education system (Douglass, 1997).

In 1996, the Fifth Circuit Court’s decision in *Hopwood v. University of Texas Law School* ruled admissions processes unlawfully discriminated against Caucasian applicants, prohibiting race-conscious admissions and funding (Webster, 2007). The effect of this decision was rapid. According to the Office of Institutional Studies at the University of Texas (1989-1999), the year immediately following the ruling, the number of African Americans and Hispanics admitted decreased by almost 25%, while the number of applications experienced only a 13% decrease. During this same period, there was a 14% increase in Caucasian enrollment. In 1997, the Texas state legislature passed the Top Ten% Rule to tackle the drop in minority acceptances (Webster, 2007). The Top 10% Rule is guarantee admission into the state’s colleges and universities for all secondary students graduating in the top 10% of their class, void of race and ethnicity. The year after its enactment, African American enrollment increased from 2.7% to 3%, and Hispanic enrollment improved from 12.6% to 13.2% at the University of Texas at Austin (Webster, 2007).

Also in 1996, the state of California passed Proposition 209, abolishing all practices of affirmative action in public contracting and hiring, as well as education, which led the way for seven other states plus the University of Georgia to follow in subsequent years (Kidder & Gándara, 2015). The aftermath of this decision caused minority applicants and enrollment to plummet the following year at the University of
California’s Los Angeles, San Diego, and Berkeley campuses by 45-55% (Card & Krueger, 2005).

Affirmative action continued to be a controversial subject in the United States. In 2003, the United States Supreme Court in its 5-4 ruling in *Grutter v. Bollinger* found that race could be one of many factors for college admissions at the University of Michigan’s Law School without necessarily infringing on the Equal Protection Clause of the 14th Amendment since the admission process was individualized (Smithsonian National Museum of American History, n.d.a). Conversely, in *Gratz v. Bollinger*, the U.S. Supreme Court ruled that the University of Michigan’s undergraduate admission policy was too generalized and ruled that it was unconstitutional to award points to minorities solely based on race, geography and legacy (Smithsonian National Museum of American History, n.d.a).

Lawsuits against affirmative action policies in higher educational institutions still exist today. In 2012, in *Fisher v. University of Texas*, Abigail Fisher challenged the university’s admission’s policy, stating it infringed upon her civil and constitutional rights by considering race in its admissions policy (Mulhere, 2016). The University of Texas utilizes the Top Ten Percent Law, which guarantees admission for the top 10% of its high school graduating seniors to the state’s colleges and universities (Mulhere, 2016). Ms. Fisher graduated in the top 12% of her class, but felt that her denial was based on her not being a minority, which she believed violated her equal protection rights under the 14th Amendment (Dunleavy & Gutman, 2012). The U.S. Supreme Court heard oral arguments of the case and gave an unclear ruling, which sent the case back to the lower
courts (Norval, 2015) where the U.S. Court of Appeals for the Fifth Circuit ruled in favor of the University of Texas. The following year, Fisher filed a new case in the Supreme Court, alleging that the lower courts misunderstood the issue, and the U.S. Supreme Court agreed to rehear the case. Its 2016 decision upheld the ruling of the lower court.

History of Hispanic Education in the United States

Contreras and Valverde (1994) explained, “Segregation, strictly speaking, refers to the setting apart and isolation of individuals or groups. In the United States, that practice resulted in the exclusion of non-White students from a fundamentally adequate education (p. 470). In 1946, almost a decade before the Brown v. Board of Education decision, Mexican Americans received their first legal segregation victory in federal court. In Méndez v. Westminster School District (161 F. 2d 774) of Orange County, California, the trial court decided separate educational facilities with the same technical facilities violated the equal protection rights of the Constitution (Smithsonian National Museum of American History, n.d.c). In 1948, the first Mexican American segregation case was filed in the state of Texas. In Delgado v. Bastrop Independent School District, the Ninth Circuit Court ruled in favor of Delgado, stating the district’s segregated policies violated the 14th Amendment (Allsup, 2010b.). Both cases preceded Brown v. Board of Education of Topeka’s landmark case where the United States Supreme Court deemed de jure segregation in public education was unconstitutional (Smithsonian National Museum of American History, n.d.c).

Prior to Brown v. Board of Education, Hispanics experienced deplorable educational conditions and refusal of access to adequate schooling, like their Black
counterparts (Greenfield & Kates, 1975). MacDonald (2013) noted the purpose of the U.S. compulsory educational system was to (a) develop educated citizens to participate in the democratic process; (b) integrate migrants to American society and language; and (c) prepare a steady labor force for a mobile market. MacDonald (2013) further recognized that citizens who migrated from European nations assimilated with full citizenry into the nation’s polity, whereas Hispanics had to depend on constitutional rights to procure equity in schooling.

The Brown v. Board of Education of Topeka (1954) decision not only addressed discrimination against Blacks in the United States, but it also opened doors for numerous initiatives designed to improve the educational conditions of other minority groups, notably Hispanics (San Miguel, 2004). The Supreme Court ruling formed desegregation stratagems, such as reallocating resources and busing, as well as birthed programs such as Title I, magnet schools, and bilingual and multilingual education (Contreras & Valverde, 1994). As with Blacks, Hispanics had to rely on the U.S. judicial system to receive equal educational opportunities.

Although Blacks began to experience a change in their educational plight, Mexican Americans victories were quickly derailed because Mexicans and other Hispanics were classified as White for purpose of desegregation (Contreras & Valverde, 1994). Despite the Méndez, Delgado, and Brown decisions, school administrators continued to segregate Mexican Americans from White students (Contreras & Valverde, 1994). Although the U.S. Supreme Court recognized Mexican Americans as an identifiable ethnic group in Hernandez v. Texas in 1954, the technicality was not
repudiated until *Cisneros v. Corpus Christi Independent School District* in 1970 (Allsup, 2010a). School districts attempted to use Hispanic students to racially balance Black schools. The courts ruled in favor of Cisneros, declaring that Mexican Americans were to be classified as an identifiable ethnic minority group for the purposes of public school desegregation. In a later ruling in 1973, *Keyes v. School District No. 1, Denver*, the Supreme Court stated, in comparison to White students, African American and Hispanic students underwent identical treatment, and Mexican Americans had the constitutional right to be documented as a distinct minority (Horn & Kurlaender, 2010).

Soon after, the U.S. Supreme Court ruled in the 1974 *Lau v. Nichols* case against San Francisco’s local school district and ordered school districts that received federal funds to “take affirmative steps to rectify the language deficiency in order to open its instructional program to these students” (*Lau v. Nichols*, 1974, p. 414). The plaintiffs of this case that began as a class-action lawsuit were Chinese-speaking students in San Francisco who were being denied an equal education because of lack of English skills (Sugarman & Widess, 1974). The unanimous decision of the U.S. Supreme Court allowed other minority groups to benefit from its decision. While the outcome of this case did not require mandatory bilingual education, it spurred its nationwide advancement. Tougher government regulations and executive decisions further supported the movement toward bilingual education in the nation (San Miguel, 2004).

The *Lau* ruling called for mandatory bilingual education that required segregation of Mexican American children based on language conflicting with the desegregation rulings (San Miguel, 2004), which required the integration of Mexican American children
throughout the school systems as a restructuring strategy. In *Tasby v. Estes*, the district court challenged the scattering of Hispanic students in perspective of desegregation. The 1976 ruling ordered accessibility of bilingual education to everyone by authorizing majority to minority transfers. Further, the court acknowledged Hispanic minorities as an ethnic group for the purposes of equal protection (Justia, 2018).

Mexican Americans overcame many challenges to obtain access to equitable education. Obstacles included *separate but equal, segregation, recognized as an identifiable ethnic group, language barriers*, and in 1981, the state of Texas endeavored to authorize legislature to restrict access for undocumented children to receive public K-12 education. In 1982, in *Plyler v. Doe*, the U.S. Supreme Court ruled it was unconstitutional to withhold state funding for children who have illegally entered the United States, and denying access to public education violates the Equal Protection Clause of the 14th Amendment (MacDonald, 2013). Although several states attempted to challenge the Supreme Court’s ruling, the *Plyler v. Doe* ruling still stands.

Theoretical Framework: The Model of Institutional Action

Although research on student attrition is voluminous and arguments over theories of student persistence are plentiful (Braxton, Hirschy, & McClendon, 2004; Kuh et al., 2005; Pascarella & Terenzini, 2005; Seidman, 2005; Tinto, 1997; Tinto & Goodsell, 1994), limited attention has been directed towards a plan of action for institutions to adhere to that provides effective guidelines to improve student persistence (Tinto, 2012). Tinto asserted such theories have not provided the leaders of institutions with information to implement effective programs and policies for student persistence. Tinto and Pusser’s
(2006) Institutional Action Model attempts to give institutions a methodical approach of developing, organizing, and implementing actions to enhance student success, which leads to improved student retention (Tinto, 2012). Tinto (2012) argued for the development of a framework that places success in the classroom as the center of attention. For institutions to drastically improve retention and graduation rates of their student body, especially marginalized students, Tinto emphasized that attention must be directed towards the manner classes are structured, taught, and aligned with other courses in order to progress along a clear pathway to program completion.

To increase retention and graduation rates, college and university officials need to examine their own behavior and initiate systems that foster and produce the intended outcomes for success (Tinto, 2012). Tinto claimed both two- and four-year institutions are compelled to work within their powers to help retain and matriculate students through to graduation once a student enrolls in their college or university. According to Tinto (2012), research agrees on four conditions that institutions can adhere to heighten student retention: expectation of climate, support, feedback, and involvement. The absence of one condition reduces the effectiveness of the others. Figure 2 demonstrates a sparse model of institutional action. The variables, nonfixed items, in the model are institutional commitment; the climate of expectation established by the institution; the support systems provided by the institution (financial, social and academic); the feedback rendered to and about students by the college or university; and institutional planned activities that impact the student’s educational and social involvement with other students.
within the classroom and on campus. The following sections provide an in-depth discussion of these variables.


Institutional Commitment

The commitment institutions make to increase student success rates is critical, for without such commitment nearly all efforts at enhancement are insignificant and
impermanent (Tinto & Pusser, 2006). Clark (1996) noted institutional commitment is an indication of institutional leadership and the inclination of leadership to subsidize capital, which influences student success (Ryan, 2004). According to Serow, Brawner, and Demery (1999), institutional leadership must not solely exist by the actions of top-tiered administrators—support and buy-in must exist at all levels of leadership, for they directly affect the alacrity of faculty and staff to support programs and activities that improve student success (Umbach & Porter, 2002). Institutions dedicated to improving student success, particularly among impoverished and underrepresented students, tend to find a way to achieve the expected outcome (Tinto & Pusser, 2006). Every successful program must have (a) robust campus-wide support from institutional administrators and downward; (b) evaluation of student needs and dependence on data-driven, research-centered practices; (c) faculty and staff support and buy-in when developing programs; (d) provision of extensive guidance and assistance; and e) content and skill training (Texas Higher Education Coordinating Board [THECB], 2011). Highly competitive institutions share a utilitarian “culture of success” (THECB, 2011, p. 2), where student success is typically the central focus of the institution’s mission statement.

Expectational Climate

Expectations can have a potent effect upon a student’s accomplishments (Tinto, 2012). The expectational or campus climate of a college or university pertains to the expectations the colleges and universities maintain for the conduct of scholars, faculty, and staff (Tinto & Pusser, 2006). Tinto and Pusser’s (2006) model of institutional action defines the expectational climate as providing the expectational perspective for individual
achievement, which affects student success because of how expectations often manipulate the way individuals respond to one another and the numerous strains upon their time and energies. Schilling and Schilling (1999) claimed expectations for student execution in the classroom are consequential because of the significance expectations have on the quality of student effort.

Tinto and Pusser (2006) delineated a condition for student success as lofty expectations, for students do not rise to meager expectations. Students with elevated expectations and weak achievement experience higher chances of college enrollment than do students with weak expectations and elevated achievement (Bates & Anderson, 2014). Although individual expectations are measures of future success, student expectations are not isolated, but involve many vital components, such as parent’s expectations, institutional support and expectations, and peer goals (Bates & Anderson, 2014).

Various individuals shape an institution’s expectational climate. Tinto (2012) claimed the most important person for the institutional action is the chancellor or president. The head of the institution plays a vital role in allocation of resources and sets the vision and tone for the college or university and its many members. Without the chancellor or president’s full, verbalized commitment to student success, particularly for marginalized students, it is almost impossible to imagine sizeable advancement in student success over time (Tinto, 2012).

Support

The next condition to promote student success is support, which can be subdivided into three categories: academic, social, and financial (Tinto, 2012). Academic
support programs vary from institution to institution. Some institutions of higher education have provided services such as mentoring programs, cohorts, learning communities, peer counseling, career counseling, tutoring services, and academic advisors to help ensure a successful first year (Purnell & Blank, 2004). These services are not only resourceful, but they also teach effective strategies for overcoming the challenges that first-year students encounter. Regardless of the type, academic support is extremely important to the success of students deemed not ready for college academically, where a disproportionate number of students come from low-income households (Muraskin & Lee, 2004).

Tinto and Pusser (2006) identified social support as the availability of advising, coaching, and ethnic student centers that aid individual students and provide a safe place for groups of underrepresented individuals to acclimate to the culture of the institution. Tinto further noted social support programs are an integral part of the design of constructive strategies for student success. Tinto’s (1993) widely accepted college student departure theory, which emphasizes the importance of institutional support on educational persistence, relates how successful amalgamation of students into an institution reduces their likelihood of departure.

Tinto (2012) noted that student success is partially dependent on whether a student can pay for college expenses. With the cost of attending college on the rise, undergraduates—particularly at four-year institutions—are encountering new pressure to fund their college expenses (College Board, 2013). While students in the past had to deal with financial pressures of paying for college, students now are subject to dependence on
both conventional and nonconventional methods of paying for college (College Board, 2013). Students are receiving less support from the federal government in the form of grants and are acquiring an increased amount of student loans to pay their educational expenses (Solis & Durband, 2015). In 1967, approximately 241,000 students from 1,700 colleges and universities received financial assistance (Schrader, 1969); over 6,200,000 students took advantage of government loans to pay for college every year (Solis & Durband, 2015). In the last 40 years, more than 50 million college students utilized the entitlement programs offered by the federal government to assist in paying for their education (Solis & Durband, 2015).

Feedback

The next condition for student success is feedback, which can take several forms (Angelo & Cross, 1993; Cottell & Harwood, 1998; Ewell, 1997; Tinto & Pusser, 2006; White, 2005). Feedback, given as a measure of developmental assessment, alerts students to any gaps that occur between their anticipated goal and their present knowledge, proficiency, or ability, which can be helpful in directing them through the necessary processes to attain the goal (Ramaprasad, 1983; Sadler, 1989). According to Tinto (2012), individuals have a greater chance of succeeding in settings that afford faculty, staff, and students repeated feedback on their performance.

Involvement

The last condition for student success is involvement, which includes both academic and social engagement (Astin, 1984; Tinto, 1975, 1993), for it is one of the most significant aspects driving student success (Astin, 1984; Borglum & Kubala, 2000;
According to Wilson and colleagues (2015), a vast number of studies show that both social and academic integration are vital to determining student achievement and persistence. Tinto and Pusser’s (2006) model utilizes such integration in which students are to accept and achieve a sense of belonging with the norms and culture of the institution, which directly affect student learning and retention in college.

Summary of the Model of Institutional Action

Tinto and Pusser’s (2006) model for institutional action focuses on the four conditions of expectation of climate, support, feedback, and involvement within colleges and universities, as opposed to student characteristics. Although student attributes matter greatly, this study focused on institutional polices, practices, and programs. Student success does not randomly happen—institutions need to develop plans of action intentionally and methodically to involve faculty, students, and staff in order to succeed (Tinto, 2012). According to Tinto (2012), there is a high probability that student success will occur when all four conditions exist.

Current Status of STEM in the United States

Creating ample numbers of college graduates who are prepared for science, technology, engineering, and mathematics (STEM) professions has become a central focus for the United States (Chen & Soldner, 2013). Throughout the 1900s, the driving sources of innovation behind the U.S. economy were higher education, technology, and science. The expeditious spread of the research and development operation after World War II, enabled by the expansion of two- and four-year higher educational institutions
and consequent surges in the quantity of capable college STEM graduates, led to robust economic performance, excellent jobs, and prosperous new businesses motivated by new technologies (PCAST, 2012).

Global Outlook

While the United States has been a global frontrunner in scientific and technological innovation, it is encountering aggressive competition from around the world in generating and maintaining STEM talent (NSB, 2010). The United States is currently risking its future by losing its long-held position in STEM education (PCAST, 2012). Although the total number of conferred undergraduate degrees in science and engineering has increased across all segments of the U.S. population since 2000, the United States continues to fall behind its global competitors (NSB, 2016). Of the 34 member countries belonging to the Organisation for Economic Co-operation and Development (OECD), the United States is currently ranked 27th for the number of college graduates who earned a degree in STEM fields (OECD, 2015). The same report also noted in 2012, approximately 5 out of every 100 conferred undergraduate degrees in the United States were in engineering, compared to almost 17 out of every 100 undergraduate degrees throughout all of Asia and approximately 32 out of every 100 undergraduate degrees in China (OECD, 2015).

The necessity for STEM expertise spreads to the entire population of the United States where STEM products play a significant and increasing role in the lives of individuals who live there (PCAST, 2012). PCAST (2012) advised that an independent society in which a vast number of individuals are unacquainted or uneasy with technical
and scientific developments faces enormous economic difficulties in worldwide competition. According to the National Science Board (2016), goods, manufacturing, and development gained through research and development are observable parts of a nation’s economic activity. Science and engineering familiarity is gradually becoming pivotal to production in the marketplace. Businesses that greatly epitomize innovative knowledge and technical advances in production possess 29% of worldwide economic yield (NSB, 2016).

Shortage of STEM Professionals

Numerous authors, scholars, politicians, and national leaders have emphasized the critical need for increased production of STEM professionals in the United States in order to remain competitive in the global economy (Fries-Britt, Younger, & Hall, 2010; Museus, Palmer, Davis & Maramba, 2011; Palmer, Moore, Davis, & Hilton, 2010; PCAST, 2012). Analysts project the United States will need to add approximately one million more STEM professionals to its labor force by 2022 (Lacey & Wright, 2010; Langdon, McKittrick, Beede, Khan, & Doms, 2011; PCAST, 2012). Georgetown University’s Center on Education and the Workforce analysis indicated a 0.3% rate of increase of jobs requiring STEM skills in the United States between 2008 and 2018, which equates to one million additional jobs (Carnevale, Smith, & Strohl, 2010) where 92 out of every 100 jobs will require some form of postsecondary education and training (Carnevale ET AL., 2011).

The shortage of STEM professionals in the United States is not a recent problem. The United States has continually relied on foreign-born STEM workers to fill unmet
labor demands (PCAST, 2012). The most astute students from around the world have migrated to the United States to further their education (Freeman, 2009); in fact, foreign-born postgraduate students account for approximately 40% of science and engineering degrees (Alberts, 2007; Freeman, 2009; Han, Stocking, Gebbie, & Appelbaum, 2015).

With the enforcement of stricter immigration policies, issues of global competitiveness, and the attracting of students to pursue degrees from international university systems, the enrollment rate of foreign-born science and engineering students is declining. Thus, there is no longer a guaranteed future flow of international STEM students within the U.S. STEM pipeline (Alberts, 2007; Freeman, 2009; Han et al., 2015; PCAST, 2012).

Reliance on foreign-born students may render the U.S. security and economy vulnerable, since the students’ desire to serve the needs of their homeland may grow accordingly (PCAST, 2012).

Surplus of STEM Professionals

Not all researchers believe there is a STEM crisis in the United States. According to Xue and Larson (2015), for the past 10 years, there has been extensive apprehension over the adequacy of the STEM labor force. One reason is the span of STEM occupations spread across a large range of careers, from natural research scientists to mathematicians, with varied levels of experience from undergraduate degrees to postdoctorate studies (Xue & Larson, 2015). According to Cataldi, Siegle, Shepherd, and Cooney (2014), the demand for STEM majors depends on the profession. The fulltime employment rates for computer and information science majors and engineering and engineering technology majors are 77.1% and 83.2%, respectively, with median salaries
of $66,000 and $67,000, whereas the fulltime employment rates for biological and physical sciences, science technology, mathematics, or agricultural sciences is 71.4%, with a median salary of $46,800, which aligns with nonSTEM majors.

The STEM crisis is a matter of supply versus demand; each year colleges and universities award more STEM degrees than there are STEM jobs (Charette, 2013; Teitelbaum, 2014). Teitelbaum (2014) posited because employers are not increasing salary offers to lure new talent, many of the science and engineering professions salaries have flattened or are growing slowly, and the fact that unemployment rates in several STEM occupations match those of skilled laborers is evidence there is a surplus of STEM professionals in the United States. Salzman, Kuehn, and Lowell (2013) noted there are twice as many students graduating with U.S. STEM degrees as being hired to work in STEM jobs, and approximately 32 out of every 100 computer science graduates not working in their field credited lack of job availability for their situation. The U.S. Census Bureau (2014) reported 7% of students who possess undergraduate STEM degrees are working in nonSTEM occupations.

Charette (2013) noted that newly STEM graduates, existing STEM degree holders, nondegree STEM workers, and H-1B visa holders are factors that contribute to the surplus of STEM professionals in the United States. The U.S. H1-B visa is a “non-immigrant visa that allows U.S. companies to employ foreign workers in specialty occupations that require theoretical or technical expertise in specialized fields such as in architecture, engineering, mathematics, science, and medicine” (Patrick, 2013, para. 1). Individuals who obtain H1-B visas can stay in the United States for up to six years.
Bracey (2009) noted that imported STEM workers from other countries work for less pay than do U.S. skilled workers in the same fields.

**Summary of Current Status of STEM in the United States**

Is there a STEM shortage or STEM surplus? According to Xue and Larson (2015), both instances are true—it depends on the field within STEM that you are examining. There is a surplus of STEM talent in the natural and life science fields, but a shortage in undergraduate engineering and technology fields (Charette, 2013). Researchers on both sides of the argument agree that foreign-born workers play a pivotal role in the status of STEM in the United States. The United States has become reliant on individuals who obtain H1-B visas to fill STEM jobs (PCAST, 2012), and such reliance has caused a surplus in STEM talent (Charette, 2013).

Some of the most elite students from around the world attend colleges and universities in the United States; however, immigration policies have made it increasingly more difficult to retain such talent beyond graduation (Information Technology Industry Council, 2015). In 2013, foreign-born students who possessed H1-B visas and lacked a well-defined path to remain in the United States accounted for 56.3% and 52.2% of engineering and math/computer science doctoral-level students, respectively (Chen & Soldner, 2013). Foreign-born STEM graduates return to their native country after graduation to compete against U.S. STEM professionals. One out of three students on a temporary student visa who earned their Ph.D. in science and engineering in 2006 no longer worked in the United States five years later (Finn, 2014). Since that time, immigrant visa backlogs have doubled, causing the exit rate of foreign-born students to
continue to increase (Travel.State.Gov., 2015). PCAST (2012) argued for the need to increase the number of U.S.-born graduates in STEM majors from all sectors of its society to combat the dependency of foreign-born STEM workers.

Factors that Contribute to STEM Attrition

Baber (2015) maintained there was a concerted effort to gear students toward postsecondary participation in STEM education in the United States. Political leaders, financial experts, and scholars are highly concerned about the diminishing rates of conferred STEM degrees among U.S.-born students (Chen & Soldner, 2013; Fairweather, 2008; NSB, 2012). To address the declining rates, various governmental and institutional initiatives are directing their attention towards developing STEM talent among Hispanics, African Americans, and Native Americans, the underrepresented pool of postsecondary STEM talent (Baber, 2015).

STEM Interest

STEM interest for all U.S.-born citizens is on the rise, but the interest is short-lived; both secondary and postsecondary educational institutions in the United States struggle to maintain STEM talent. Approximately 28% of high school freshmen aspire to major in STEM related fields once in college; of these, more than 57% will abandon their STEM interest and declare a nonSTEM major prior to graduating from high school (Munce & Fraser, 2013). The lack of interest trend continues when a student enrolls in undergraduate college and again in graduate school. For example, prior to enrolling in college, the U.S. college freshmen class of 2007-2008 had approximately 33% of its freshmen who aspired to major in a STEM-related field (NSB, 2012). However, only
14% of the entire freshmen class across the United States majored in a STEM-related field (Snyder & Dillow, 2011). National data show that more than 50% of freshmen who declared STEM majors at the beginning of college abandoned these majors prior to graduation (Chen & Soldner, 2013). Furthermore, more than 50% of individuals who earned a STEM undergraduate degree pursued nonSTEM fields when they enrolled in graduate school or entered the workforce (Lowell, Salzman, Bernstein, & Henderson, 2009; NSB, 2016).

Underrepresented minority students, particularly students of African American, Hispanic, Native American, and Pacific Islander descent, enter U.S. institutions of higher education with the same aspirations of completing a STEM degree as their White counterparts (Crisp, Nora, & Taggart, 2009). Despite the similarity, a disproportionate number of conferred undergraduate STEM degrees among African Americans and Hispanics in the United States exists compared to other ethnicities (American Institutes for Research [AIR], 2013). Women and underrepresented minorities tend to exit out of undergraduate STEM programs at considerably greater rates than nonunderrepresented males do (Chen & Soldner, 2013; Hill et al., 2010; Huang, Tadese, & Walter, 2000; Kokkelenberg & Sinha, 2010; PCAST, 2012; Shaw & Barbuti, 2010). STEM Barriers

Various factors affect how well a student transitions into college. According to McDonald and Farrell (2012), variables such as family support, existing proficiencies, and previous schooling while interacting with personal intentions and goals, in addition to institutional, academic, and social experiences (Tinto, 1993), play a key role in how
efficacious a student integrates into college. For numerous reasons, first-generation college, underrepresented students may face greater obstacles with respect to factors that affect successful integration into the college climate (Matthews & Mellom, 2012; Pascarella, Pierson, Wolniak, & Terenzini, 2003; Ramos-Sanchez & Nichols, 2007).

Once in college, students who exhibit weak academic skills experience greater STEM attrition than students with stronger academic backgrounds do (Chen & Soldner, 2013; Kokkelenberg & Sinha, 2010; Shaw & Barbuti, 2010; Whalen & Shelley, 2010). The studies of Burtner (2005) and Huang et al. (2000) connected STEM attrition with such factors as motivation, self-confidence, and belief in one’s ability to comprehend STEM material. Lastly, compared to nonSTEM degrees, the completion of STEM degrees often takes longer, which could impact a student’s ability to pay for college and thus, remain in college (Fenske, Porter, & DuBrock, 2000; Whalen & Shelley, 2010).

STEM Experiences

In addition to being academically underprepared and exhibiting the aforementioned attitudinal factors, individuals may lose of interest in STEM programs because of identified classroom related factors. These include students encountering negative experiences while taking the gatekeeper or introductory math and science courses (Barr, Gonzalez, & Wanat, 2008; Crisp et al., 2009; Mervis, 2010); students receiving limited exposure to STEM coursework within the first two years of study, (Bettinger, 2010); and students performing much better in nonSTEM courses compared to STEM courses (Ost, 2010; Rask, 2010; Stinebrickner & Stinebrickner, 2011).
When examining factors related to STEM attrition, student perceptions or experiences associated with the culture or climate of the institution or workplace need to be explored (Chen & Soldner, 2013). Additional factors related to students departing from STEM fields at different times in college include insufficient academic advising, career counseling, and institutional support; feelings of seclusion in STEM fields due to limited number of peers pursuing STEM degrees and limited number of available role models and mentors, primarily pertaining to women and underrepresented minorities; and perceived sexual, racial or ethnical discrimination in the STEM workforce (Chen & Soldner, 2013). Eagan, Herrera, Sharkness, Hurtado, and Chang (2011) noted students’ negative experiences may include large learning environments, passive learning methods, limited direct interaction with faculty, language barriers due to large number of professors or facilitators from foreign countries, and faculty perceived to value research over teaching. Eagan and colleagues (2011) further noted the rigorous design and limited available support for gatekeeper courses filtered out weaker students.

Hispanics and African Americans in Higher Education in the U.S.

Chen and Soldner (2013) conducted a Beginning Postsecondary Students Longitudinal Study (BPS) in 2004/2009 and the associated 2009 Postsecondary Education Transcript Study (PETS) for the National Center for Education Statistics (NCES). The six-year study followed a cohort of students beginning in from 2003 to 2009. Researchers used a multinomial probit model (MNP) to assess how different factors were connected to STEM attrition, after accounting for related factors. Prior to the MNP analysis, the conducting of a bivariate analysis revealed STEM attrition
correlated with numerous factors, including “students’ demographic characteristics, precollege academic preparation, types of first institution enrolled, and STEM coursetaking and performance” (Chen & Soldner, 2013, p. v). The MNP analysis simultaneously studied these factors and revealed even more in-depth information: taking heavy credit loads in STEM courses in the first year, taking challenging math courses in the first year, and performing well in STEM courses reduced STEM attrition more than any of the other factors studied (Chen & Soldner, 2013).

Based on the findings from numerous studies, including the aforementioned NCES study, students need to be academically prepared for college in order to take challenging courses during their first year. A commonly used benchmark used to determine student preparedness for college is the Scholastic Achievement Test (SAT) College and Career Readiness Benchmark. Students who score a minimum combined SAT score of 1550 in critical reading, writing, and mathematics on the SAT are deemed academically prepared for college (College Board, 2013).

The College Board’s 2013 SAT Report on College & Career Readiness addressed 1,657,633 SAT test takers from the graduating class of 2013—86.1% of the entire 2013 graduating class. The report revealed 57% of the SAT takers from the high school graduating class of 2013 were not academically prepared for the rigors of college-level course work. This number had remained stagnant for the five previously reported years. In 2012, just 22.8% and 14.8% of Hispanics and African Americans respectively met or exceeded the SAT Benchmark, whereas in 2013, the numbers improved to 23.5% and 15.6% respectively (College Board, 2013). Furthermore, although there has been an
increase in the number of Hispanics and African Americans who met or exceeded the SAT Benchmark, there is still a critical need to expand access to rigorous coursework to improve these numbers. Of the students who met the SAT Benchmark, 78% enrolled in a four-year college, 77% maintained a B- grade point average (GPA) their first year of college, 54% graduated in four years, and 77% graduated in six years. Of the students who did not meet the SAT Benchmark, 46% enrolled in a four-year college, 51% maintained a B- GPA their first year of college, 27% graduated in four years, and 53% graduated in 6-years (College Board, 2013).

The characteristics of students who met the SAT College and Career Readiness Benchmark included taking high-level math courses, taking the PSAT/NMSQT, completing a core curriculum, taking AP/honors courses, and ranking in the top 10 percent of their high school graduating class (College Board, 2013). Figure 3 shows the academic characteristics possessed by students who met or did not meet the SAT Benchmark, and Figure 4 shows the academic preparation of underrepresented students.
The SAT Benchmark and Academic Characteristics

- Ranked in the Top 10% of H.S. Grad. Class
- Took AP/Honor Courses
- Completed a Core Curriculum
- Took the PSAT/NMSQT
- Took High-Level Math (Calc/Precal/Trig)

Figure 3. SAT benchmark and academic characteristics. Adapted from “College Board’s 2013 SAT Report on College & Career Readiness,” p. 5. Copyright 2013 by College Board, www.collegeboard.org.

Academic Preparation of Underrepresented Students in the U.S.

- Completed a Core Curriculum
- Took AP/Honor Courses
- Took at least 1 AP Course
- Reported GPA of A+/A/A-

The College Board (2013) concluded that if our nation is to make meaningful strides in closing the educational attainment gap, all students must have access to these characteristics: “When students are prepared, they enter college, persist, and complete at much higher rates than those who are not prepared” (p. 3).

In 2012, 70% of Hispanic and 56% of African American high school graduates enrolled in college, compared to 66% of White students of which just 16% of Hispanics and 15% of African Americans were enrolled at the undergraduate level compared to 59% for Whites (Chen & Soldner, 2013). Of those, 15.5% of Hispanics, 22.5% of African Americans and 36.2% of Whites graduated with a bachelor’s degree or more. Hispanics and African Americans who earned top SAT scores who enrolled in selective colleges graduated at a rate of 73%, as opposed to a rate of 40% for equally qualified Hispanics and African Americans enrolled at open-access campuses (Carnevale & Strohl, 2013). While there has been a significant increase in college enrollment and degree attainment for Hispanics and African Americans, Hispanic and African American students completing degrees are underrepresented in science, technology, engineering, and mathematics (Brown et al., 2015; Hrabowski, 2015; Zambrana et al., 2015).

Benefits of STEM Diversity for Hispanics and African Americans

According to Gibbs (2014), “Diversity in science refers to cultivating talent, and promoting the full inclusion of excellence across the social spectrum. This includes people from backgrounds that are traditionally underrepresented and those from backgrounds that are traditionally well represented” (p. 1). He further noted diversity is critical to excellence, the lack of diversity represents a loss of talent, and enhancing
diversity is key to long-term economic growth and global competitiveness. Closing the STEM degree attainment gap for African Americans and Hispanics could significantly improve the number of individuals capable of doing jobs in high-growth areas of the economy that require advanced-level skills (Miller & Horrigan, 2014), and earn substantially more than nonSTEM professionals (Chen & Soldner, 2013). The face of the workforce is changing with the adage of younger workers and minorities throughout the United States. However, since 2001, the demographics of STEM professions have remained virtually the same (Bidwell, 2015).

Currently, almost 50% of individuals who fall below the poverty threshold of $28,960 are Hispanics and African Americans (U.S. Census Bureau, 2015). In 2014, Hispanics had the second lowest median household income in the United States of all ethnic groups at $42,491, whereas African Americans had the lowest at $35,398 (U.S. Census Bureau, 2015). Within the last 30 years, residential segregation by household income has significantly increased, which forced children living in impoverish communities to be at an extreme disadvantage in educational attainment (Reardon & Bischoff, 2011). Disproportions in educational attainment aggravate disparities in other areas, such as financial stability and physical wellness. Obtaining a college education has been regarded as an effective equalizer in diminishing disparities and improving social mobility (Espenshade & Radford, 2009).

The NCES 2014 Baccalaureate and Beyond Report studied a sample of 137,800 undergraduate students from the 2007-2008 graduating class four years after graduation (Cataldi et al., 2014). This class was comprised of 72.9% Whites, 8.6% African
Americans, 9.2% Hispanics, 5.8% Asian and 3.5% other, of which 16.2% earned a STEM degree, and 83.8% earned nonSTEM degrees. The average STEM salary in 2012 was $65,000, compared to the average nonSTEM salary of 49,500 (Chen & Soldner, 2013). The STEM degree holders earned more than twice the poverty threshold of $28,900 and could serve as role models within their communities.

Summary

This chapter offered a discussion of the history of STEM education and the ways it has been a driving force throughout the history of the United States, from General Washington’s desire to create an educational system for soldiers to learn the art of warfare and military science, to the merging of global minds and experiences of various military in wartime, then onward to President Obama’s goal of out-innovating and out-educating the rest of the world. STEM innovations have allowed the United States to be among the top leaders of the world, but in recent years, United States has lost its edge, falling in rank to 27th in world. Throughout the history of STEM, White males have been the dominate STEM degree holders with limited input from other ethnic groups, but to meet the President’s mandate and improve U.S. ranking, STEM professions need to become more diversified by including all segments of the population.

The review of literature in this chapter provided evidence for the barriers Hispanic and African Americans encountered, beginning with their history of inequality and the obstacles they faced while trying to gain educational equality. The examined studies clearly demonstrated the need for improvement among the number of Hispanic and African American STEM professionals. The United States has one of the lowest STEM-
to-nonSTEM-degree attainment ratios in the world. Hispanics and African Americans represent almost 30% of the U.S. population, yet only account for 13% of the conferred STEM degrees. Underrepresented minority college freshmen exhibit a high interest in STEM fields, but they are short-lived. Numerous factors account for why students leave STEM fields, including self-confidence, motivation, institutional support, student-faculty interaction, student involvement, and institutional climate. However, the leading factor is the lack of academic preparedness, in which Hispanics and African Americans fare the worst.

Additionally, this chapter presented a review of studies demonstrating the disparities between ethnic groups in the United States as it pertains to STEM interests, academic preparedness, AP courses, STEM attrition, median household incomes, poverty, STEM vs. nonSTEM salaries, and the benefits of STEM diversity. The researcher explored Tinto and Pusser’s (2006) Institutional Action Model to examine the polices, practices, and programs colleges and universities should offer to successfully graduate Hispanic and African American STEM majors at selective Research I STEM institutions.

The next chapter provides an explanation and rationale of the research design used in this study. Also discussed are the participant sample, data collection procedures, and methods of data analyses. Chapter 4 presents the results, and Chapter 5 provides a discussion of the results, as well as implications and recommendations for future research.
CHAPTER 3

METHODOLOGY

Although the total number of conferred undergraduate degrees in science and engineering has increased across all segments of the U.S. population since 2000, the United States continues to fall behind its global competitors (National Science Foundation, 2016). According to Chen (2014), “Domestic STEM degree production is not keeping pace with the demand for STEM talent. As a nation, our STEM education and workforce development infrastructure have realized a poor return on investment” (p. iv). The United States currently awards the ninth highest number of STEM conferred degrees in the world (Craig, Thomas, Hou, & Mathur, 2011).

Prior to the Obama era, success of science in the United States produced greater global competition among nations. Xie (2014) reported immigrant scientists in 1960 represented approximately 7% of practicing scientists in the United States, whereas in 2014, more than one-fourth of scientists practicing in the United States were foreign-born and received their education from U.S. universities. However, in the past most foreign-born scientists chose to remain in the United States. Foreign-born STEM workers significantly add to U.S. innovation (Kerr & Lincoln, 2010); nondomestic college graduates tend to be innovative (Hunt & Gauthier-Loiselle, 2010); and their contributions are significant (Peri, Shih, & Sparber, 2015). Additionally, research demonstrates that highly skilled immigrant employees harmonize domestic employees in U.S. companies
(Kerr, Kerr, & Lincoln, 2015), and foreign-born workers make extensive contributions to the growth (Bound, Khanna, & Morales, 2017). Xie (2014) further noted,

If the flow of foreign students to U.S. science programs should stop or dramatically decline, or if most foreign students who graduate with U.S. degrees in science should return to their home countries, this could create a shortage of U.S. scientists, potentially affecting the U.S. economy or even national security. (para. 17)

During President Trump’s first 100 days in office, he signed several immigration-related Executive Orders (EOs). One order, EO 13768, titled Enhancing Public Safety in the Interior of the United States, stated that “sanctuary jurisdictions” (The White House, 2017b, sec. 9) that refused to comply with immigration enforcement measures would not be “eligible to receive Federal grants, except as deemed necessary for law enforcement purposes” (The White House, 2017b, sec. 9a). This order was ruled unconstitutional in April 2017. Another order, EO 13767 (2017), titled Border Security and Immigration Enforcement Improvements, directed the building of a wall along the Mexico-United States border (The White House, 2017a). In April of the same year, President Trump signed the Buy American and Hire American Executive Order (The White House, 2017c), designed to overhaul the H1-B Visa program and make it more difficult for foreign-born workers to arrive and remain in the United States. President Trump asked governmental agencies “to help ensure that H-1B visas are awarded to the most-skilled or highest-paid petition beneficiaries” (The White House, 2017c, sec. 5b).
To address the domestic STEM deficit, President Obama’s Council of Advisors on Science and Technology (PCAST) developed the Engage to Excel initiative that set out to produce an additional one million domestic STEM professionals in the upcoming decade (PCAST, 2012). The Trump administration’s Summary of the 2018 State-Federal STEM Education Summit (The White House Office of Science and Technology Policy, 2018) educational focus continued the efforts of former President Obama’s for improving domestic STEM production. Also noted was the critical role of STEM on the future of the U.S. labor force as the cornerstone of developing essential skills for careers that will give the United States the needed competitive edge of leading the scientific world.

Trump (as cited in The White House Office of Science and Technology Policy, 2018) claimed, “Skills in STEM—including, in particular, computer science . . . open the door to jobs, strengthening the backbone of American ingenuity, driving solutions to complex problems across industries, and improving lives around the world” (p. 2).

Since 2008, the number of STEM degrees awarded to Asians, Pacific Islanders, Hispanics, American Indians, and Alaskan Natives have steadily increased among U.S. citizens. However, the number of STEM degrees awarded to African Americans has remained stagnant (American Institutes for Research, 2013). Although Hispanics are experiencing a continual increase of the number of conferred STEM degrees in the United States, the growth is not keeping pace with their population growth (Krogstad & Lopez, 2015). To address the shortage of STEM professionals in the next decade, PCAST (2012) proposed continuously increasing the production of STEM professionals by 34% annually. PCAST (2012) asserted, “Increasing the retention of STEM majors
from 40% to 50% would generate three-quarters of the targeted one million additional STEM degrees over the next decade” (p. 7).

This study followed the protocol of a nonexperimental research design. The researcher did not manipulate independent variables, but studied them in their natural state to determine their possible relationship to the outcome (dependent) variable of degree completion rates of African American and Hispanic STEM majors at highly selective, Research I STEM institutions. This chapter includes the following sections: reiteration of the research questions; research design; variables; population and sample; data retrieval; IRB; data analysis; results; and summary.

Research Questions Reiterated

The purpose of this quantitative study was to examine the differences in institutional success in improving the recruitment, retention, and degree completion of Hispanic and African American STEM majors at the 39 top-ranked Research I universities that grant the largest proportion of their bachelor’s degrees in STEM fields in the United States. Furthermore, the researcher examined if institutional success varied by policies, strategies, platforms, and programs initiated at the selected institutions.

The overarching research question aligns with Tinto and Pusser’s (2006) Institutional Action Model: Does the institution’s strategic plan include a strategy for improving the degree completion rates for minority STEM students?

The research questions that guided this study are:

1. Are there differences in the White, Hispanic, and African American degree completion rates among Research I STEM institutions?
2. If so, is the variability among completion rates related to students’ precollege achievements?

3. If so, is the variability among completion rates related to financial opportunities afforded to students?

4. If so, is the variability among completion rates related to minority recruitment programs?

5. If so, is the variability among completion rates related to institutional minority programs?

6. If so, is the variability among completion rates related to summer bridge programs for minority STEM majors?

7. If so, is the variability among completion rates related to the institution having a plan of action for improving graduation rates for African American and Hispanic American STEM majors?

Research Design

The researcher examined 39 doctoral granting Research I STEM institutions in the United States. The selected schools were chosen since they represented the 39 top-ranked Research I universities that grant the largest proportion of their bachelor’s degrees in STEM fields in the United States. The information displayed in Figure 5 shows the percentage of undergraduate student enrollments for each institution by race, whereas Table 3 shows an overview of the characteristics of the selected schools for the study. The institutions consisted of both public and private schools with undergraduate student enrollments ranging from 1001 to 48,960 students. The percentage of conferred STEM
degrees ranged from 33% to 98%, with overall six-year undergraduate graduation rates for all populations ranging from 71% to 96%.

Figure 5. Ethnicity of undergraduate student enrollment at selected institutions. Data derived from “Use the Data,” by Integrated Postsecondary Education Data System, 2016.
Table 3

<table>
<thead>
<tr>
<th>Institution</th>
<th>% STEM degrees conferred</th>
<th>National Ranking</th>
<th>Type</th>
<th>Under Grad Enroll</th>
<th>% Grad within 6 years</th>
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<tbody>
<tr>
<td>California Institute of Technology</td>
<td>98%</td>
<td>10</td>
<td>Private</td>
<td>1001</td>
<td>91%</td>
</tr>
<tr>
<td>Colorado School of Mines</td>
<td>98%</td>
<td>77</td>
<td>Public</td>
<td>4608</td>
<td>77%</td>
</tr>
<tr>
<td>Missouri Univ. of Science &amp; Tech</td>
<td>91%</td>
<td>125</td>
<td>Public</td>
<td>6841</td>
<td>65%</td>
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<tr>
<td>Worcester Polytechnic Institute</td>
<td>88%</td>
<td>65</td>
<td>Private</td>
<td>4299</td>
<td>85%</td>
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<td>Massachusetts Inst. of Technology</td>
<td>86%</td>
<td>6</td>
<td>Private</td>
<td>4527</td>
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<td>Rensselaer Polytechnic Institute</td>
<td>84%</td>
<td>41</td>
<td>Private</td>
<td>5864</td>
<td>81%</td>
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<td>Stevens Institute of Technology</td>
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<td>75</td>
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<td>82%</td>
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<td>1839</td>
<td>75%</td>
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</tr>
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</tr>
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</tr>
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</tr>
<tr>
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<td>65</td>
<td>Public</td>
<td>29497</td>
<td>74%</td>
</tr>
<tr>
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<td>17</td>
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</tr>
<tr>
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<td>83</td>
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<td>3406</td>
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</tr>
<tr>
<td>Lehigh University</td>
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<td>5075</td>
<td>88%</td>
</tr>
<tr>
<td>University of Rochester</td>
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<td>33</td>
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<td>88%</td>
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<tr>
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<td>21</td>
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<td>27496</td>
<td>91%</td>
</tr>
<tr>
<td>Johns Hopkins University</td>
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<td>13</td>
<td>Private</td>
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</tr>
<tr>
<td>University of California – Davis</td>
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<td>38</td>
<td>Public</td>
<td>28384</td>
<td>N/A</td>
</tr>
<tr>
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<tr>
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<tr>
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<td>44</td>
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</tr>
<tr>
<td>Duke University</td>
<td>36%</td>
<td>8</td>
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<td>6639</td>
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<td>35%</td>
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</tr>
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<td>33%</td>
<td>46</td>
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<td>40742</td>
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</tr>
</tbody>
</table>

Note. Data derived from “Use the Data,” by Integrated Postsecondary Education Data System, 2016.
Variables

The variables in this study are classified as independent, dependent, and exogenous. According to Salkind (2013), an independent variable is a predictor or a controlled variable for research analysis. For this study, the researcher used students’ precollege achievements by examining the 25th and 75th percentile for SAT and ACT scores; percentage of minority students who had taken AP calculus and/or computer science classes compared to their counterparts; the average number of AP courses taken in high school for both minorities and White students; and the average high school GPA for the different ethnic groups. The researcher also examined the financial opportunities afforded to minority students by determining if the institution had grants, scholarships, or work study opportunities designated for minority STEM students; if the school was a need-blind institution; and the size of the institutions endowment. The researcher further examined the minority outreach programs designed for middle and high school students and identified if each institution had minority recruitment programs designed to improve minority STEM enrollment. Finally, the researcher examined if each institution had specific strategies outlined within the strategic plan that addressed ways to improve enrollment, retention, and degree attainment rates for minority STEM majors.

Salkind (2013) explained that a dependent variable is the predicted outcome in research analysis. The researcher selected STEM degree completion rates as the dependent variable to determine whether the independent variables served as predictors of high degree attainment rates for African American and Hispanic STEM majors. Martin and Bridgmon (2012) defined extraneous variables as unwanted variables that
influence the outcome of a study and could produce similar outcomes as the dependent variable. The researcher’s goal was to always minimize the impact of such variables on the study. One way to handle extraneous variables is to use partial correlation that allows the researcher to examine the relationship between two variables while controlling for a third variable. The researcher also used block regression to handle exogenous variables. For this study, extraneous variables that may alter the degree attainment rates among African American and Hispanic STEM majors could be associated with a student’s study habits, lack of finances, little or no academic or family support, poor motivation, social economic status and being academically underprepared for college level coursework.

Population and Sample

The population of this study was selected by using data retrieved from 2017 Federal Integrated Postsecondary Education Data System (IPEDS) reports for all undergraduate students at the 39 selected institutions. The sample of this study consisted of Hispanic, African American, and White STEM majors at the 39 selected institutions.

Data Retrieval

The procedures for the retrieval of data involved the use of three secondary data sets. The researcher obtained the data obtained from publicly available sources. The first source was the Integrated Postsecondary Education Data System (IPEDS), a system of interrelated surveys guided annually by the U.S. Department’s National Center for Education Statistics (NCES). According to NCES (n.d.), “IPEDS gathers information from every college, university, and technical and vocational institution that participates in the federal student financial aid programs” (para. 7). To examine the policies and
procedures each institution had in place, the researcher also accessed information from institutional websites and institutional catalogs.

Institutional Review Board Permission Procedures

After the completion of the dissertation proposal and the approval of the dissertation committee, the researcher applied and received permission to conduct this study from the Institutional Review Board (IRB) at Mercer University (see Appendix A). Since secondary data were used in this study, all further deidentification was waived. Because the dataset included only numerical data, the researcher received exemption for having to complete informed consent forms.

Data Analysis

The researcher examined the role students’ precollege achievement, financial opportunities afforded to students, minority recruitment programs, summer bridge programs, institutional characteristics, and institutional minority programs have on the degree completion rates of African American and Hispanic STEM majors at the 39 top-ranked U.S. Research I universities that confer at least one-third of their undergraduate degrees in STEM fields. The researcher utilized quantitative methods, since the heart of quantitative research emphasizes the relationship between variables (Punch, 2003).

Institutional websites, catalogs, strategic plans, and IPEDS reports were used to retrieve data. The researcher examined the policies, strategies, platforms, and programs institutions had in place to determine the role of institutional practices on high degree completion rates of minority STEM majors at the selected institutions.
To analyze the data retrieved from the dataset, the researcher used IBM Statistical Package for the Social Sciences (SPSS) version 24. The three advantages of using SPSS are (a) SPSS effectively manages and organizes the data; (b) SPSS generates various graph and charts to display the data; and (c) SPSS offers an in-depth analysis of the data (Begum & Ahmed, 2015). More specifically, the analysis of the data from the 39 institutions was parametric, thus, parametric statistical procedures were used.

The researcher utilized histograms and $t$-tests to analyze the first research question to determine if there were differences in the six-year graduation rates of White, Hispanic, and African American STEM majors at the selected institutions. For the remaining questions, the researcher first used Pearson’s correlation analyses to determine if there was an association between students’ precollege achievement, financial opportunities afforded to students, minority recruitment programs, summer bridge programs, institutional characteristics, and institutional minority programs and the differences in degree completion rates of Hispanic and African American STEM majors at the selected institutions. A multiple regression analyses was then conducted to determine whether the independent variables served as predictors of high degree completion rates for Hispanic and African American STEM majors at the selected institutions. The researcher used an alpha value of .05 to ensure the validity of the study. According to Salkind (2013), regression equations represent the relationship of independent and dependent variables in the form of a linear equation, which is based upon the observed data. Salkind further asserted that when the correlation between the
variables are high, regression equations are the single best approximation of the entire data set in a single line.

Displaying Results

After the data were retrieved and analyzed, the reporting of the results of the study consisted of tables categorizing the retrieved data. The researcher also used charts to display descriptively the results of the analyses. The researcher developed prediction models based on SPSS’s calculated correlation and multiple regression coefficients.

Summary

The purpose of this quantitative study was to address the disproportionate number of conferred STEM degrees for African American and Hispanic STEM majors in the U.S. by determining whether institutional programs and institutional characteristics are predictors of high degree completion rates at highly selective Research I STEM institutions. Using a nonexperimental research design, the researcher examined independent variable to determine any possible relationships to the degree completion rates of African American and Hispanic STEM majors at 39 Research I STEM institutions. The researcher completed repeated measures analyses and one-way ANOVA analyses for the study. Chapter 4 presents the findings of the study.
CHAPTER 4

RESULTS

This chapter presents the results and findings based on data collected and analyzed on improving the graduation rates of African American and Latino American STEM majors at 39 colleges and universities in the United States. This chapter recaps the seven research questions that guided the study, describes the thirty-nine institutions examined in the research study, and uses quantitative analysis to present the findings.

The purpose of the research was to determine if differences existed in institutional policies, programs and practices that contributed to improvements in the degree completion rates of Hispanic and African American STEM majors at the 39 top-ranked Research I universities that grant the most STEM degrees in the United States. The researcher further examined if institutional success varied by policies, strategies, platforms, and programs initiated at the selected institutions. The research focused on the problem of the underrepresentation of Hispanic and African American students completing degrees STEM (Brown et al., 2015; Hrabowski, 2015; Zambrana et al., 2015).

Respondents

The researcher examined 39 doctoral granting Research I STEM institutions in the United States. The selected schools represented the 39 institutions in the United States where at least one-third of conferred bachelor’s degrees were awarded in STEM fields. Table 3 is duplicated for easy reference. The information displayed shows an
overview of the characteristics of the selected schools for the study. The institutions consisted of both public and private schools with undergraduate student enrollments ranging from 1001 to 48,960 students. The percentage of conferred STEM degrees were 33% or more with at least 70% overall six-year undergraduate graduation rates for all populations.
Table 3

Characteristics of Selected Institutions (N=39)

<table>
<thead>
<tr>
<th>Institution</th>
<th>% STEM degrees conferred</th>
<th>National Ranking</th>
<th>Type</th>
<th>Under-Graduate Enroll</th>
<th>% Grad within 6 years</th>
</tr>
</thead>
<tbody>
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<td>98%</td>
<td>10</td>
<td>Private</td>
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<td>91%</td>
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<td>125</td>
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</tr>
<tr>
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<td>41</td>
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</tr>
<tr>
<td>SUNY College of Env. Sci &amp; For.</td>
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<td>77</td>
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<td>1839</td>
<td>75%</td>
</tr>
<tr>
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<td>113</td>
<td>Private</td>
<td>2991</td>
<td>73%</td>
</tr>
<tr>
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<td>23</td>
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<td>6454</td>
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</tr>
<tr>
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<td>6</td>
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<td>6999</td>
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</tr>
<tr>
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<td>Private</td>
<td>5121</td>
<td>81%</td>
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<tr>
<td>University of California – San Diego</td>
<td>49%</td>
<td>38</td>
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<td>23850</td>
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<tr>
<td>North Carolina State University</td>
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<td>106</td>
<td>Public</td>
<td>24111</td>
<td>76%</td>
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<tr>
<td>Cornell University</td>
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<td>15</td>
<td>Private</td>
<td>14315</td>
<td>93%</td>
</tr>
<tr>
<td>Purdue University</td>
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<td>65</td>
<td>Public</td>
<td>29497</td>
<td>74%</td>
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<tr>
<td>Rice University</td>
<td>44%</td>
<td>17</td>
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<td>3910</td>
<td>86%</td>
</tr>
<tr>
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<td>28312</td>
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<tr>
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<td>72</td>
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<td>25384</td>
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</tr>
<tr>
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<td>83</td>
<td>Private</td>
<td>3406</td>
<td>73%</td>
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<tr>
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<td>5075</td>
<td>88%</td>
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<td>University of Rochester</td>
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<td>33</td>
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<td>6304</td>
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</tr>
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<td>University of California – Berkeley</td>
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<td>21</td>
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<td>27496</td>
<td>91%</td>
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<td>Johns Hopkins University</td>
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<td>13</td>
<td>Private</td>
<td>5386</td>
<td>94%</td>
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<tr>
<td>University of California – Davis</td>
<td>38%</td>
<td>38</td>
<td>Public</td>
<td>28384</td>
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<td>30034</td>
<td>71%</td>
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<td>Princeton University</td>
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<td>1</td>
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<td>5402</td>
<td>N/A</td>
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<td>65</td>
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<td>48960</td>
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<td>Duke University</td>
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<td>8</td>
<td>Private</td>
<td>6639</td>
<td>94%</td>
</tr>
<tr>
<td>Brown University</td>
<td>35%</td>
<td>15</td>
<td>Private</td>
<td>6652</td>
<td>96%</td>
</tr>
<tr>
<td>Clemson University</td>
<td>35%</td>
<td>68</td>
<td>Public</td>
<td>18016</td>
<td>81%</td>
</tr>
<tr>
<td>University of California – L.A.</td>
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<td>29585</td>
<td>91%</td>
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<td>46</td>
<td>Public</td>
<td>33368</td>
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<tr>
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<td>83</td>
<td>Private</td>
<td>16464</td>
<td>68%</td>
</tr>
<tr>
<td>Penn State University – Univ. Park</td>
<td>33%</td>
<td>46</td>
<td>Public</td>
<td>40742</td>
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</tr>
</tbody>
</table>

Note. Data derived from “Use the Data,” by Integrated Postsecondary Education Data System, 2016.
Findings

The research findings for the seven research questions that guided this study are presented and examined in this section. The research questions are presented followed by a synopsis and table of results based on the analysis of each question. The researcher organized the data by institutions sorted within the years 2011-2016. This is a “stacked” organization where the data rows are sorted first by years, and then by institution within each year. The rows of the data contain the year – repeated 39 times. After which the 39 institutions are sorted ascending by their names within each year totaling 234 rows of data. The appropriate data – variable scores - are given for each institution within each year. The researcher called the data “Long” to account for its massive size by the number of rows of data.

Research Question 1

Research question 1 asked, “Are there differences in the White, Hispanic, and African American degree completion rates among the selected institutions?” A one-way repeated-measures ANOVA was calculated comparing the graduation rates of African-American, Hispanic, and White STEM majors. A significant effect was found \((F(1,233) = 143.645, p < .001)\). The tests of within-subjects and between-subjects shown in Tables 4 and 5 demonstrate there is a significant difference.
Table 4

Tests of Within-Subjects: Racial Differences (N=39)

<table>
<thead>
<tr>
<th>Measure Source</th>
<th>Measure Race</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race</td>
<td>Linear</td>
<td>0.116</td>
<td>1</td>
<td>0.116</td>
<td>143.645</td>
<td>.000</td>
<td>.381</td>
</tr>
<tr>
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<td>Quadratic</td>
<td>0.017</td>
<td>1</td>
<td>0.017</td>
<td>20.664</td>
<td>.000</td>
<td>.081</td>
</tr>
<tr>
<td>Error (Race)</td>
<td>Linear</td>
<td>0.188</td>
<td>233</td>
<td>0.001</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>0.194</td>
<td>233</td>
<td>0.001</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 5

Tests of Between-Subjects: Racial Differences (N=39)

<table>
<thead>
<tr>
<th>Measure Source</th>
<th>Measure Race</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>22.418</td>
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<td>22.418</td>
<td>4453.983</td>
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<td>.950</td>
</tr>
<tr>
<td>Error</td>
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<td>1.173</td>
<td>233</td>
<td>0.005</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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</tbody>
</table>

Research Question 2

Research question 2 asked, “If so (differences in the White, Hispanic, and African American degree completion rates among the selected institutions), is the variability among completion rates related to students’ precollege achievements?” A 3 x 3 mixed-design ANOVA was calculated to examine the effects of race (African American, Hispanic, and White) and precollege achievements (ACT and SAT test scores) on degree completion rates. No significant interactions were found. The race x precollege achievements interaction and precollege achievement were not significant. However, the
main of effect for race was significant. Thus, minority STEM graduation rates were not related to precollege achievements. The tests of within-subjects and between-subjects shown in Tables 6, 7, and 8 demonstrate there is no significant difference.

Table 6

Tests of Within-Subjects: Precollege Achievements

<table>
<thead>
<tr>
<th>Measure: Measure 1</th>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Race</td>
<td>Sphericity Assumed</td>
<td>.133</td>
<td>2.000</td>
<td>.067</td>
<td>81.230</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greenhouse-Geisser</td>
<td>.133</td>
<td>1.818</td>
<td>.073</td>
<td>81.230</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Huynh-Feldt</td>
<td>.133</td>
<td>1.839</td>
<td>.072</td>
<td>81.230</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower-bound</td>
<td>.133</td>
<td>1.000</td>
<td>.133</td>
<td>81.230</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Race *</td>
<td>Sphericity Assumed</td>
<td>.002</td>
<td>2.000</td>
<td>.001</td>
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</tr>
<tr>
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<td>Long_Avg_</td>
<td>Greenhouse-Geisser</td>
<td>.002</td>
<td>1.818</td>
<td>.001</td>
<td>1.016</td>
<td>.357</td>
</tr>
<tr>
<td></td>
<td>Test Scores</td>
<td>Huynh-Feldt</td>
<td>.002</td>
<td>1.839</td>
<td>.001</td>
<td>1.016</td>
<td>.358</td>
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<tr>
<td></td>
<td></td>
<td>Lower-bound</td>
<td>.002</td>
<td>1.000</td>
<td>.002</td>
<td>1.016</td>
<td>.315</td>
</tr>
<tr>
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<td>Error (Race)</td>
<td>Sphericity Assumed</td>
<td>.380</td>
<td>464.000</td>
<td>.001</td>
<td>N/A</td>
<td>N/A</td>
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<td></td>
<td></td>
<td>Greenhouse-Geisser</td>
<td>.380</td>
<td>421.676</td>
<td>.001</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Huynh-Feldt</td>
<td>.380</td>
<td>426.653</td>
<td>.001</td>
<td>N/A</td>
<td>N/A</td>
</tr>
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<td></td>
<td></td>
<td>Lower-bound</td>
<td>.380</td>
<td>232.000</td>
<td>.002</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note. * denotes the interaction of race with Long_Avg Test_Scores.
### Table 7

*Tests of Within-Subjects Contrasts: Precollege Achievements*

<table>
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<tr>
<th>Source</th>
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<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta²</th>
</tr>
</thead>
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<tr>
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<td>1</td>
<td>.116</td>
<td>144.252</td>
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<td>.383</td>
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<tr>
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<td>1</td>
<td>.017</td>
<td>20.578</td>
<td>.000</td>
<td>.081</td>
</tr>
<tr>
<td>Race * Long_Avg Test Scores</td>
<td>Linear</td>
<td>.001</td>
<td>1</td>
<td>.001</td>
<td>1.744</td>
<td>.188</td>
<td>.007</td>
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<tr>
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<td>Quadratic</td>
<td>.000</td>
<td>1</td>
<td>.000</td>
<td>.315</td>
<td>.575</td>
<td>.001</td>
</tr>
<tr>
<td>Error (Race)</td>
<td>Linear</td>
<td>.187</td>
<td>232</td>
<td>.001</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>.194</td>
<td>232</td>
<td>.001</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Table 8

*Tests of Between-Subjects Effects: Precollege Achievements*

<table>
<thead>
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<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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</table>
Research Question 3

Research question 3 asked, “If so (differences in the White, Hispanic, and African American degree completion rates among the selected institutions), is the variability among completion rates related to financial opportunities afforded to students?” A 3 x 3 mixed-design ANOVA was calculated to examine the effects of race (African American, Hispanic, and White) and financial opportunities afforded to minorities on degree completion rates. No significant interactions were found. The race x financial opportunities interactions were not significant. Thus, minority STEM graduation rates were not related to financial opportunities afforded to minority STEM majors. The tests of within-subjects and between-subjects shown in Tables 9 through 11 demonstrate there is no significant difference.

Table 9

Tests of Within-Subjects: Financial Opportunities

<table>
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<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta²</th>
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<td>.097</td>
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<tr>
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<td>.103</td>
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<tr>
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<td>1.866</td>
<td>.002</td>
<td>2.343</td>
<td>.101</td>
</tr>
<tr>
<td></td>
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<td>.004</td>
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Table 9 (continued)

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<td>.000</td>
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Note. a Long_instate; b Long_outstate; c Long_Percent of fulltime firsttime undergraduates awarded any finan; d LONG_Percent of fulltime firsttime undergraduates awarded federal; e LONG_Percent of fulltime firsttime undergraduates awarded Pellgrant; f Long_Average amount of Pellgrant aid awarded to fulltime firsttime
Table 10

*Tests of Within-Subjects Contrasts: Financial Opportunities*

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<th>F</th>
<th>Sig.</th>
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*Note.* a Long_instate; b Long_outstate; c Long_Percent of fulltime first time undergraduates awarded any finan; d LONG_Percent of fulltime first time undergraduates awarded federal; e LONG_Percent of fulltime first time undergraduates awarded Pellgrant; f Long_Average amount of Pellgrant aid awarded to fulltime first time
Table 11

*Tests of Between-Subjects Effects: Financial Opportunities*

<table>
<thead>
<tr>
<th>Measure: Measure 1</th>
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<td>Source</td>
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<td>Intercept</td>
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</tr>
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<td>b</td>
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<tr>
<td>c</td>
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</tr>
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<td>d</td>
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<td>e</td>
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<tr>
<td>f</td>
<td>.008</td>
</tr>
<tr>
<td>Error</td>
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</table>

*Note.*

$^a$Long_instate; $^b$Long_outstate; $^c$Long_Percent of fulltime firsttime undergraduates awarded any finan; $^d$LONG_Percent of fulltime firsttime undergraduates awarded federal; $^e$LONG_Percent of fulltime firsttime undergraduates awarded Pellgrant; $^f$Long_Average amount of Pellgrant aid awarded to fulltime firsttime

Research Question 4

Research question 4 asked, “If so (differences in the White, Hispanic, and African American degree completion rates among the selected institutions), is the variability among completion rates related to minority recruitment programs?” A 3 x 3 mixed-design ANOVA was calculated to examine the effects of race (African American, Hispanic, and White) and minority recruitment on degree completion rates for minority STEM majors. A significant interaction between race and minority recruitment was found. The race x minority recruitment interactions was significant. Thus, an institution’s minority recruitment practices are related to minority STEM graduation
rates. The tests of within-subjects and between-subjects shown in Table 12 through 14 demonstrate there is a significant difference.

Table 12

*Tests of Within-Subjects: Minority Recruitment*

<table>
<thead>
<tr>
<th>Measure: Measure 1</th>
<th>Type III Sum of Squares</th>
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<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta²</th>
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<td>.026</td>
<td>32.223</td>
<td>.000 .122</td>
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<td>.029</td>
<td>32.223</td>
<td>.000 .122</td>
</tr>
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<td>Huynh-Feldt</td>
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<td>.029</td>
<td>32.223</td>
<td>.000 .122</td>
</tr>
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<td></td>
<td>Lower-bound</td>
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<td>1.000</td>
<td>.053</td>
<td>32.223</td>
<td>.000 .122</td>
</tr>
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<td>.002</td>
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<td>.144 .008</td>
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<td>Huynh-Feldt</td>
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<td>Lower-bound</td>
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<td>.003</td>
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<td>N/A</td>
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<tr>
<td></td>
<td>Lower-bound</td>
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<td>232.000</td>
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</table>

*Note.* ¹LONG_Number Recruitment_Programs
Table 13

Tests of Within-Subjects Contrasts: Minority Recruitment

<table>
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<tr>
<th>Measure: Measure 1</th>
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<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
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<td>.010</td>
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<td>.047</td>
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Note. a LONG_Number Recruitment_Programs

Table 14

Tests of Between-Subjects Effects: Minority Recruitment

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<th>Sig.</th>
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Note. a LONG_Number Recruitment_Programs

Research Question 5

Research question 5 asked, “If so (differences in the White, Hispanic, and African American degree completion rates among the selected institutions), is the variability among completion rates related to institutional minority programs?” A 3 x 3 mixed-
design ANOVA was calculated to examine the effects of race (African American, Hispanic, and White) and institution’s minority programs on degree completion rates of African American and Hispanic STEM majors. No significant interactions were found. The race x minority programs interactions were not significant. Thus, minority programs offered by institutions did not influence minority STEM graduation rates. The tests of within-subjects and between-subjects shown in Tables 15-17 demonstrate there is no significant difference.

Table 16

Tests of Within-Subjects: Minority Programs

<table>
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<th>Sig.</th>
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<td>Huynh-Feldt</td>
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<td>1.841</td>
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<td>.045</td>
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<td>.262</td>
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<td>1.820</td>
<td>.001</td>
<td>1.342</td>
<td>.262</td>
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<td>1.841</td>
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<td>N/A</td>
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Note. a LONG Number Min Institutional Programs
Table 16

*Tests of Within-Subjects Contrasts: Minority Programs*

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<td>N/A</td>
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</table>

*Note. a* LONG Number Min Institutional Programs

Table 17

*Tests of Between-Subjects Effects: Minority Programs*

<table>
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<th>Measure: Measure 1</th>
<th>Transformed Variable: Average</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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<td>0.008</td>
<td>1.650</td>
<td>.200</td>
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<td>232</td>
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<td>N/A</td>
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</table>

*Note. a* LONG Number Min Institutional Programs

Research Question 6

Research question 6 asked, “If so (differences in the White, Hispanic, and African American degree completion rates among the selected institutions), is the variability
among completion rates related to summer bridge programs for minority STEM majors?”

A 3 x 3 mixed-design ANOVA was calculated to examine the effects of race (African American, Hispanic, and White) and summer bridge programs on degree completion rates. No significant interactions were found. The race x summer bridge programs interactions were not significant. Thus, summer bridge programs offered to minority STEM majors did not influence minority STEM graduation rates. The tests of within-subjects and between-subjects shown in Tables 18 through 20 demonstrate there is no significant difference.

Table 18

Tests of Within-Subjects: Summer Bridge Programs

<table>
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<tr>
<th>Source</th>
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<th>F</th>
<th>Sig.</th>
<th>Partial Eta²</th>
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</thead>
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<td>.036</td>
<td>43.624</td>
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<td>.158</td>
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<td>Greenhouse-Geisser</td>
<td>.072</td>
<td>1.822</td>
<td>.039</td>
<td>43.624</td>
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<td>.039</td>
<td>43.624</td>
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Note: a LONG_Number_Summer_Bridge_Programs
Table 19

*Tests of Within-Subjects Contrasts: Summer Bridge Programs*

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<th>Measure: Measure 1</th>
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<th>F</th>
<th>Sig.</th>
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<td></td>
<td>Quadratic</td>
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<td>1</td>
<td>.000</td>
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<td>N/A</td>
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*Note.* $^a$ LONG_Number_Summer_Bridge_Programs

Table 20

*Tests of Between-Subjects Effects: Summer Bridge Programs*

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<th>Transformed Variable: Average</th>
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*Note.* $^a$ LONG_Number_Summer_Bridge_Programs

Research Question 7

Research question 7 asked, “If so (differences in the White, Hispanic, and African American degree completion rates among the selected institutions), is the variability among completion rates related to the institution having a plan of action for improving
graduation rates for African American and Hispanic American STEM majors?” A 3 x 3 mixed-design ANOVA was calculated to examine the effects of race (African American, Hispanic, and White) and institution’s plans of action for closing the degree completion gap among African American, Hispanic and White STEM majors. A significant interaction was found. The race x plan of action was significant. Thus, minority STEM graduation rates were related to institutions plans of action. The tests of within-subjects and between-subjects shown in Tables 21 through 23 demonstrate there is a significant difference.

Table 21

Tests of Within-Subjects: Action Plan (N=39)

<table>
<thead>
<tr>
<th>Measure:</th>
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<td>6.696</td>
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<td></td>
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Note. $^a$LONG_Action_Plan
Table 22

Tests of Within-Subjects Contrasts: Action Plan (N=39)

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Note. aLONG_Action_Plan

Table 23

Tests of Between-Subjects Effects: Action Plan (N=39)

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Note. aLONG_Action_Plan

Summary

Approximately 50 percent of college students initially interested in STEM fields either choose another major or exit college without attaining a degree. The degree completion rates within six years for URMs drops to less than 33 percent (Lisberg &
The widening conferred degree gap between African American STEM students and Caucasian STEM students, as well as Hispanic American STEM students and Caucasian STEM students, led to this research, which focused on improving the graduation rates of minority STEM students in the United States. The researcher examined policies, strategies, platforms, and programs initiated at the 39 selected institutions.

SPSS 24 served to enter, organize, and analyze the archived data. Once the data was stacked, a series of descriptive statistics, one-way repeated measures of analysis of variance (ANOVA) tests, and mixed method ANOVA tests were performed to answer the seven research questions that guided the study. The Repeated-Measures ANOVA test was used to determine if there was a statistically significant difference between the graduation rates of African American, Hispanic, and White STEM majors. The Mixed Design ANOVA tests were used to determine if students’ precollege achievement, financial opportunities afforded to students, minority recruitment programs, summer bridge programs, institutional minority programs, and institution’s plans of action were statistically and significantly different between minority and White STEM students.

Research question 1 focused on determining if there was a significantly statistically difference between the degree completion rates of White, Hispanic and African American STEM majors at the selected institutions. The data revealed there is a statistically significant difference in the degree completion rates among the races.

Research questions 2 through 6 centered on determining if there were statistically significant differences between students’ precollege achievement, financial opportunities
afforded to students, minority recruitment programs, summer bridge programs, and institutional minority programs respectively, and the degree completion rates of minority STEM majors. The data revealed no statistically significant difference in the degree completion rates between minority and White STEM majors for each of the questions.

Research question 7 concentrated on determining if there was a significantly statistically difference between the number of conferred STEM degrees of minority STEM majors and the institution having a plan of action for improving graduation rates for African American and Hispanic American STEM majors. The data revealed there is a statistically significant difference in the degree completion rates of minority STEM majors when institutions have a plan of action in place for improving graduation rates for minority STEM majors.

Chapter 5 provides a comprehensive discussion of the findings of the study in relation to the presented literature in Chapter 2. Chapter 5 also includes implications, the researcher’s recommendations for future studies, and conclusions as they pertain to the problem statement and the background of the problem.
CHAPTER 5

SUMMARY, DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

The problem of the disproportion amount of undergraduate conferred STEM degrees for African American and Hispanic American students led the researcher to investigate factors that contribute to increasing the degree completion rates for minority STEM students. The policies, strategies, platforms, and programs initiated at the 39 top-ranked Research-I universities that grant the largest proportion of bachelor’s degrees in STEM fields in the United States were examined. The researcher collected analyzed data from the participating institutions. This chapter includes an overview of the study, beginning with the problem, purpose, methods, and findings. Furthermore, this chapter offers discussions of the major findings for the seven research questions in addition to the conclusions, implications, and the researcher’s recommendation for future studies.

Summary of the Study

The purpose of the research was to determine if differences existed in institutional characteristics that attributed to improvements in the recruitment, retention, and degree completion of Hispanic and African American STEM majors at the 39 top-ranked Research-I universities that grant the most STEM degrees in the United States. The study was centered on the problem of the underrepresentation of Hispanic and African American students completing degrees in STEM (Brown et al., 2015; Hrabowski, 2015; Renn & Lane, 2015; Zambrana et al., 2015). Despite improvements in the graduation
rates of minority STEM majors (American Institutes for Research [AIR], 2013), national
data still indicate a disproportionality in STEM degree attainment for URM students
compared to White and Asian students (National Center for Education Statistics [NCES],
2005; DePass & Chubin, 2009; Estrada et al., 2016). Estrada et al. (2016) further noted,
“At each stage of the academic process, URM students are consistently less likely to
persist in STEM degree programs than White or Asian students” (p. 1), which in turn
leads to a dearth of representation in STEM research careers. If the selected institutions’
instituted policies, strategies, platforms, and programs contributed to improved retention,
persistence, and graduation rates for Hispanic and African American STEM majors, then
the plan of addressing the perceived STEM shortfall proposed by the President’s Council
of Advisors on Science and Technology (PCAST) will begin to take affect; thus, leading
to a potential explanation of the research problem.

This study’s research design used both one-way analysis of variance (ANOVA)
and mixed method ANOVA to test archival data, after controlling for extraneous
variables. The researcher selected 39 doctoral granting Research I STEM institutions in
the United States where at least one-third of conferred bachelor’s degrees were awarded
in STEM fields. The data for questions 1 through 3 were provided by Integrated
Postsecondary Education Data System (IPEDS). The IPEDS data included the
institution’s completion rates, midrange scores for both SAT and ACT tests, and financial
opportunities afforded to minorities. The websites of the selected institutions provided
data for questions 4 through 7. The institutions’ websites data included minority
recruitment programs, other minority programs, summer bridge programs, and
institutional plans of action. Once the data were collected, the researcher analyzed each question by race.

A total of seven research questions guided the study. Descriptive statistics were used to answer each research question, which described each factor for both Hispanic American and African American STEM students in relation to White STEM students. A one-way repeated-measure ANOVA was performed to test research question 1, and a mixed method ANOVA was performed to test research questions 2 through 7. Tests of within-subjects and between subjects were used for each research question to determine if there was a statistically significant difference between Hispanic American, African American and White STEM students.

Summary of Major Findings

This section addresses the major findings of the study; the findings offer additional research surrounding factors that contribute to improved degree completion rates for Hispanic American and African American STEM majors. The researcher examined precollege achievements, financial opportunities afforded to minorities, minority recruitment, institutional minority programs, summer bridge programs, and institutional plans of action to determine if they contributed to improved degree completion rates. The IPEDS and institutional websites provided data for this study.

The study centered on whether precollege achievements, financial opportunities afforded to minorities, minority recruitment, institutional minority programs, summer bridge programs, and institutional plans of action had a statistically significant relationship to degree completion rates for Hispanic American and African American
STEM majors. The researcher stacked the data by institutions sorted within the years 2011-2016. The data rows were sorted first by years, then by institution within each year. The researcher did not have any missing data.

The researcher began the study by comparing the graduation rates of Hispanic American, African American, and White STEM majors to determine if there were differences in the graduation rates between the races. Based on $\alpha=0.5$, the researcher had enough evidence to suggest that race had a statistical significance on the graduation rates for Hispanic American and African American STEM majors. The researcher then examined six factors to determine if they had a statistical significance on improving the degree attainment rates for URMs in STEM. The researcher did not have enough evidence, based on $\alpha=0.5$, to suggest that students’ precollege achievements, financial opportunities afforded to students, institutional minority programs, and summer bridge programs had a statistical significance on improving graduation rates of Hispanic American and African American STEM majors. Based on $\alpha=0.5$, The researcher did have enough evidence to suggest that minority recruitment programs and institutional plans of action had a statistical significance on improving the degree completion rates of Hispanic American and African American STEM majors.

Discussion of Findings

The findings of the research study substantiated arguments previously supported by scholarly literature while adding to the body of research on various policies and programs implemented at STEM institutions geared to improve the low domestic STEM degree attainment rates for Hispanic and African American students. The major themes
frequently cited from the literature review, which resonated in the research study, were barriers Hispanic and African American STEM majors encountered. Research noted the need for minority students to be academically prepared and have access to financial opportunities, and institutions to have implemented programs, policies, and plans designed to improve recruitment, retention, and graduation rates of Hispanic and African American STEM majors.

The research study centered on the problem of the underrepresentation of Hispanic and African American students completing degrees in STEM (Brown et al., 2015; Hrabowski, 2015; Renn & Lane, 2015; Zambrana et al., 2015). Even though the graduation rates of minority STEM majors are moving in a positive direction (AIR, 2013), there remains a disproportionality in STEM degree attainment for URM students compared to White and Asian students (NCES, 2005; DePass and Chubin, 2009; Estrada et al., 2016). Estrada et al. (2016) noted, throughout the various stages of academic attainment, Hispanic and African American STEM students consistently lag behind their counterparts, which leads to a shortage of representation in STEM professional careers.

Mau (2016) contended that academic persistence continues to be a highly researched topic in postsecondary education (Allan, 1996; Astin, 1993; Chen & Weko, 2009; Lent, Brown, & Larkin, 1984; Malin, Bray, Dougherty & Skinner, 1980; Newton & Smith, 1996; Pascarella & Terenzini, 2005; Pascarella, Pierson, Wolniak, & Terenzini, 2004; Russell & Petrie, 1992). Fewer than 4 of every 10 freshmen students will earn a bachelor’s degree within four years, and just 6 of every 10 students will graduate within six years (Coley & Coley, 2010). A study conducted by the Higher Education Research
Institute (2010) found 42% of Asian American and 33% of White students completed their bachelor's degree in STEM within five years, compared to only 18% of African American and 22% of Latino students.

Underrepresented minorities tend to continually encounter unique challenges while attempting to move through the STEM pipeline. Putnam (2015) noted for the last half of the century, there was a limitation on the accessible opportunities to learn by societal forces designed to generate wealth and racial isolation. He further noted that not all communities prioritize the notion of delivering a quality education to all students. Students who are financially challenged tend to go to schools that are financially challenged, and the likelihood that they will receive an adequate education diminishes greatly, particularly in STEM fields (Lynch, 2000; U.S. Department of Education Office of Civil Rights, 2014; U.S. Department of Labor, Bureau of Labor Statistics, 2016).

The College Board (2017) reported 70% of Asian students and 59% of White students from the class of 2017 met or exceeded both the critical reading and mathematics benchmark compared to just 20% of African American and 13% Hispanic students. The College Board benchmark scores indicate the likelihood of a student to be ready and successful in a freshman-level course earning college-credit. While students' aptitude and secondary preparation are vital, continual advancement through the STEM pipeline also hinges on opportunities, experiences, and assistance students receive while in college (Chang, Eagan, Lin, & Hurtado, 2011; Espinosa, 2011).

Another hurdle minorities must overcome is the affordability of a college education. Barely 14% of children from low-income families reach the top 40% of the
income distribution without having a bachelor’s degree; however, with a bachelor’s degree, the chances of attaining that status are almost tripled (Haskins, Holzer, and Lerman; 2009). In addition, workers who work in STEM fields earn premium wages (Arcidiacono, 2004; Hastings, Neilson, & Zimmerman, 2013; Kirkeboen, Leuven, & Mogstad, 2016). The average entry-level salary in 2017 for STEM associate or bachelor’s degree jobs were $50,000 and $69,000 respectively, which reflects a 30% increase over starting salaries of nonSTEM associate and bachelor’s degree positions (Burning Glass Technologies, 2014). College-educated individuals possess a variety of benefits when it comes to occupation, wellness, financial stability, family structure, and the responsibilities connected with parenting (Attewell & Lavin, 2007; Hout, 2012; Lleras-Muney & Cutler, 2010; Oreopoulos & Petronijevic, 2013; Schwartz 2013; Torche, 2011). While postsecondary degrees continue to be linked with social mobility, minimal household income is associated with limited possibilities for college completion. The effects of lower income diminish the probabilities of college attendance and persistence to degree attainment (Castleman, Long, & Mabel, 2017).

Whereas institutions are selective in the admission process, they must also be purposeful in recruiting students to create a diversified population. The entrance into the STEM pipeline for institution begins with the recruitment process. The recruitment of underrepresented minority students—particularly in STEM fields—continues to be a challenge at all educational levels (Sowell, Allum, & Okahana, 2015; Whittaker & Montgomery, 2012). The Joint Working Group on Improving Underrepresented Minorities Persistence in STEM (2016) reviewed literature to determine why the STEM
“pipeline” leakage is more prevalent for URM than White or Asian students (Estrada et al., 2016). To address such leakages, Estrada and colleagues recommended intuitions establish plans that include benchmarks to monitor progress of URM STEM students; increase institutional accountability; develop strategic partnerships designed to elevate at-risk STEM students; utilize best practices for educators; address student resource disparities; and get creative.

This research study aligns with previous findings in that the selected 39 top-ranked Research I universities reported there are differences in the degree completion rates between Hispanic American, African American and White STEM students. The study also found that there was enough statistical evidence to suggest that the institutions which had minority recruitment programs and implemented plans of action for minority improvement had higher degree completion rates. However, the study failed to yield a statistically significant difference among precollege achievements, financial opportunities afforded to minorities, institutional minority programs, and summer bridge programs for Hispanic and African American STEM majors. The researcher did not have enough statistical evidence to suggest such programs improve the graduation rates for Hispanic and African American STEM majors.

The lack of statistical significance could be linked to the absence of uniformity of college websites and the broadness of the term diversity which no longer solely mean racial diversity. This allowed for the possible omission of data that perhaps hindered the study and thus its results and findings. In addition, the findings could have been more statistically significant if the study compared and contrasted schools with high degree
attainment rates with institutions with considerably lower degree attainment rates for Hispanic and African American STEM majors.

Conclusion

The research study was grounded in Tinto and Pusser’s (2006) Model of Institutional Action, which is based on the disconnect between and among an institution’s theory, research, and practice. Tinto (2012) theorized that once a student enters a college or university, the institution is obligated to have implemented strategic plans designed to help students persist through to degree attainment. Tinto and Pusser (2006) asserted that universities that fail to comprehend and execute safeguards inevitably create systems that lead to student failure. To elevate retention and graduation rates, educational leaders need to examine their own performance and initiate procedures that foster and yield the intended outcomes for success (Tinto, 2012). According to Tinto (2012), research agrees on four conditions that institutions can adhere to improve student retention: expectation of climate, support, feedback, and involvement. The absence of one condition reduces the effectiveness of the others.

The results of this study support the conclusion that a gap exists among the degree completion rates of Hispanic and African American STEM students and White STEM students. The researcher did have adequate statistical evidence to suggest minority recruitment programs and implemented institutional plans of action for minority improvement contributed to increased degree attainment rates for Hispanic and African American STEM majors at the selected institutions. However, the researcher did not have enough evidence to suggest precollege achievements, financial opportunities
afforded to minorities, summer bridge programs, and institutional minority programs contributed to improvements in the degree attainment rates for Hispanic and African American STEM majors at the selected institutions.

Implications

Educational leaders are commissioned with many responsibilities, one of which is creating and maintaining strategic plans of action that align with the vision and mission of the institution. Institutional leaders face the challenge of closing numerous gaps; one prevalent gap is the degree completion gap among Hispanic and African American STEM students compared to White STEM students. All of the 39 selected institutions selectively admitted their students and accepted a responsibility to guarantee a plan of action is in place for minority STEM students to persist through to graduation. Such action plans should help ensure academic success for struggling and/or underrepresented students by developing, implementing, and maintaining a continual plan to recruit, retain, persist, and graduate such students.

Institutional leaders and program developers committed to improving the graduation rates of minority STEM students must identify or develop systems and frameworks that address the needs of the whole student. The process begins with a purposeful system for recruiting URMs, followed by allocating funds to make college affordable by offering financial assistance, followed by offering institutional programs that address the unique social, academic, environmental, and psychological needs of minority students.
The significance of this study lies in the identification of factors that contribute to improving degree attainment for underrepresented minority STEM majors, which will equip leaders in higher education with tools to aid to close the persisting gap among the different ethnic groups and improve diversity among STEM professionals. While the current study did not suggest a statistical difference for several variables, a study without the data limitations could result in different claims.

Recommendations for Future Research

Future researchers piloting similar studies must ensure the data collected reflects all institutions equally. Due to the broadening of the definition of diversity, identifying programs solely for underrepresented minorities was very difficult to find. To alleviate the possible omission of data, future researchers could conduct a qualitative study interviewing heads of diversity programs to acquire data pertaining to policies, plans, and programs available for Hispanic and African American STEM majors.

Future research could also enlarge the study to examine if the variability among completion rates of minority and White STEM majors can be related to the amount of interaction between minority STEM faculty and minority STEM majors; institutional partnerships with industrial leaders designed for financing minority STEM student education; mentorship programs with minority alumni and/or minorities employed in STEM professions; and/or earlier exposure to the STEM pipeline beginning with elementary school programs. These recommendations will allow trackable data to be analyzed and potentially lead to more statistically significant results.
Final Thoughts

The overall purpose of this study was to determine if recruitment, retention, and degree completion of Hispanic and African American STEM majors varies by policies, strategies, platforms, and programs initiated at the 39 top-ranked Research I universities, which grant a large percentage of overall degrees in the STEM field in the United States. The selected institutions had implemented various policies, practices, and programs designed to improve the STEM degree attainment rates for minority students. In addition to adding to the body of literature regarding factors that contribute to improving degree completion rates for minority STEM majors, the findings and conclusions of this study also offered possible implications for educational leaders in implementing programs that could seal some of the leakages in the STEM pipeline. Data analysis revealed adequate statistical evidence to suggest minority recruitment programs and implemented institutional plans of action for minority improvement contributed to increased degree attainment rates for Hispanic and African American STEM majors at the selected institutions.

The greatest supposition and implication for educational leaders is that a possibility still exists for eradicating the continual leakages in the STEM pipeline for Hispanic and African American students. The vitality of educational leaders to implement a well-developed and purposeful strategic plan to address the unique needs of minority STEM students is imperative. The policies and programs birthed from these plans possess the potential to lead to great improvements in the degree attainment rates of minority students and, in turn, impact not only the life of each student, but also their
community and society—at large as well as globally. When educational leaders address the leakages in the STEM pipeline, the STEM professional population becomes more diverse, and we as a nation become more globally competitive.
REFERENCES


Munce R., & Fraser E. (2013). Where are the STEM students? What are their career interests? Where are the STEM jobs? My CollegeOptions/STEM Connector. Retrieved from https://www.dailyherald.com/assets/PDF/DA127758822.pdf


APPENDICES
APPENDIX A

IRB APPROVAL
Wednesday, April 26, 2017

Ms. Dawn N. Thomas
3001 Mercer University Drive
Atlanta, GA 30345

RE: Accepting the STEM Challenge: Factors that Contribute to Degree Attainment Rates of Hispanic and African American STEM Majors (H1704133)

Dear Ms. Thomas:

On behalf of Mercer University's Institutional Review Board for Human Subjects Research, your application submitted on 24 Apr 2017 for the above referenced protocol was reviewed in accordance with Federal Regulations 45.063 under category(ies) 4 and is Exempt from further review at this time.

Any changes to the above protocol MUST be resubmitted for IRB review to ensure that risks to the subject have not changed.

Item(s) Approved (26-Apr-2017):

Using archival data from 89 Research 1 universities, seven research questions will be analyzed using t-Tests, ANOVA, and Pearson Correlation analysis. This quantitative study will utilize archival data to examine 39 doctoral granting Research 1 STEM institutions in the United States. The selected schools represent institutions where at least one-third of conferred bachelor's degrees were awarded in STEM fields. The inquiry will examine the role of students' pre-college achievement, financial opportunities, minority recruitment programs, minority outreach programs, institutional characteristics, institutional minority programs, and degree completion rates of African American and Hispanic STEM majors. Institutional websites, catalogs, and federal Integrated Post-secondary Education Data System (IPEDS) reports will be used to retrieve data. The researcher will examine the policies, strategies, platforms, and programs institutions have in place to determine the role that institutional practices have on degree completion rates of minority STEM majors at the selected institutions. The study will address six research questions: RQ 1: Are there differences in the White, Hispanic, and African American degree completion rates among Research 1 STEM institutions? RQ 2: If so, is the variability among completion rates explained by students' pre-college achievements? RQ 3: If so, is the variability among completion rates explained by financial opportunities afforded to students? RQ 4: If so, is the variability among completion rates explained by minority recruitment programs? RQ 5: If so, is the variability among completion rates explained by institutional minority programs? RQ 6: If so, is the variability among completion rates explained by minority outreach programs?

We at the IRB and the Office of Research Compliance are dedicated to providing the best service to our research community. As one of our investigators, we value your feedback and ask that you please take a moment to complete our Satisfaction Survey and help us to improve the quality of our service.

It has been a pleasure working with you and we wish you much success with your project! If you need any further assistance, please feel free to contact our office.

Respectfully,

Ava Chambliss-Richardson, Ph.D., OP, CIM
Associate Director of Human Research Protection Programs (HRPP)
Member
Institutional Review Board

"Mercer University has adopted and agrees to conduct its clinical research studies in accordance with the International Conference on Harmonization's (ICH) Guidelines for Good Clinical Practice."
**Figure 3 and Figure 4:**

College Board (2019). *Copyright & Trademark Permission Request Instructions: Other Publications*, https://www.collegeboard.org/request-form/instructions:

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**Figure 2:**


The National Postsecondary Education Cooperative (NPEC) was established by NCES in 1995 as a voluntary organization that encompasses all sectors of the postsecondary education community including federal agencies, postsecondary institutions, associations and other organizations with a major interest in
postsecondary education data collection. NPEC’s mission is to “promote the quality, comparability and utility of postsecondary data and information that support policy development at the federal, state, and institution levels.”

The National Center for Education Statistics (NCES), *About Us*,

https://nces.ed.gov/about/

The National Center for Education Statistics (NCES) is the primary federal entity for collecting and analyzing data related to education in the U.S. and other nations. NCES is located within the U.S. Department of Education and the Institute of Education Sciences. NCES fulfills a Congressional mandate to collect, collate, analyze, and report complete statistics on the condition of American education; conduct and publish reports; and review and report on education activities internationally.


Beginning in FY 2012, IES established a Public Access Policy to Research Findings, and incorporated those requirements into awards made in FY 2012 and after.

The policy is available here: http://ies.ed.gov/funding/researchaccess.asp