

Student Participation in a STEM Preparation Program and Decision to Major and Graduate in a STEM Field at an HBCU

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Abstract

It is arguable the United States (US) lags behind in global competitiveness in providing an adequate supply of Science, Technology, Engineering, and Mathematics (STEM) workers. As the diversity of the United States population increases and is compounded by an underrepresentation of minority students pursuing a STEM, there is an increased need for minorities to pursue careers in STEM fields. This study examined if Black students' participation in the Research Initiative for Scientific Enhancement (RISE) program was related to their majoring and graduating in STEM-related fields. The study employed the science identity conceptual framework, utilized major's data of RISE program participants, and compared them with non-program. Using the Average Treatment Effect on the Treated it was found that RISE program participants decided to major and graduate from STEM fields more frequently than non-RISE. The results may inform the government, policy makers, and educational leaders about funding and establishing the RISE program.

Key Words: Graduation, Higher Education, Science, Technology, and Math

1. Introduction

This paper studied the relationship between minority students' participation in the Research Initiative for Scientific Enhancement [RISE] (NIH, 2017) a STEM enrichment program and their decisions to major and graduate in STEM-related fields. It has been argued that there exists a heightened need for minority students to pursue careers in STEM fields in the US (Bright, 2013; Casey, 2012).

There is underrepresentation of minorities in STEM, and as the percentage of minority Americans increases, *ceteris paribus*, the disparity will increase. Racial and ethnic minorities are expected to consist of more than one-half of the national population by 2050 (Jackson, 2013; Museus, Palmer, Davis, & Maramba, 2011). Minority students constituted 10% of the College of Engineering Program's undergraduate enrollment at North Carolina State University (NC State Engineering, 2014). Similarly, the *Hispanic Outlook in Higher Education* reported that there were less significant proportions of African-American, Native American, and Hispanic women in STEM majors; these minority groups were underrepresented amongst all STEM majors (McGlynn, 2009). Additionally, a National Science Foundation study on science and engineering performance indicators showed that the percentage of African American undergraduate students who were awarded degrees in STEM slowly rose from 7.7% in 1997 to 8.3% in 2006. From 2002 to 2006, this percentages remain between 8.3 and 8.4% yearly, indicating the strong need for greater enrollment and retention programs (Kendricks, Nedunuri, & Arment, 2013). More recently Bidwell (February 24, 2015) stated that according to recent reports since 2000, the number of black and latino students interested in STEM has declined. With respect to social justice and economic earnings, due to significant earnings benefits, STEM fields are one way to elevate the social classification of low-income minorities, removing them from chronic poverty (Adolino & Blake, 2011). Historically on average, those in STEM positions have garnered 26% more in earnings compared to their counterparts in other fields (Bright, 2013).

STEM enrichment programs have been established for the purpose of recruiting minority students into STEM fields (Flowers, 2009; Hansen & Gonzalez, 2014; Kendricks et al., 2013; Miller, Chang, Wang, Beier, & Klisch, 2011; Slovacek et al., 2011; Wyss, Heulskamp, & Siebert, 2012). Some of the enrichment programs were established in middle schools and high schools as well as in higher education. It is argued that minority STEM enrichment programs such as the RISE program should start enrolling their participants from the third grade and exposing them to an additional 15 minutes of independent practice with math and science programs lessons each day (Martella, Nelson, Morgan, & Marchand-Martella, 2013). This is a similar principle as Olympic participants who start preparing as early as before the age of seven, nine or an older (DeJarnette, 2012; Sundgot-Borgen & Garthe, 2011).

1.1 Background

The government initiated American colleges and universities in the 1640s, for the purpose of educating upper class White men to serve in positions of power in the New World (Thelin, 2004). Women won the right to attend colleges in the late 1770s and the government opened Salem College in North Carolina as the first American women's college in 1772. Similarly, according to Thelin (2004), the government did not recognize Blacks in the US as citizens and so they did not admit them into an exclusive institution such as the university; as an aside, Cheney University in Pennsylvania became the first Black university, in 1837. Black land-grant colleges were formed via federal grants for educating the newly freed Blacks shortly after the end of slavery in the 1890s. Several Blacks and non-Blacks became students in these colleges and universities over the years. However, little by little, minority students were also admitted to predominantly white universities (Thelin, 2004).

Although minority students were accepted into predominantly White universities, the U.S. Census Bureau (2012a), in 2009 reported, minority students 25 years and over who earned bachelor's degree or more in the US were only 17.6% Black and 12.6% Hispanic. Out of the 56 million people aged 25 and over who earned a bachelor's degree, approximately 20 million of them earned a degree in science and engineering fields (Siebens & Ryan, 2012). In addition, the U.S. Census Bureau (2012b) states, earnings in dollars of a bachelor's degree holder in STEM-related fields were \$72,415.00 annually compared to Non-STEM workers in business, education, and arts, humanities, and others with annual earnings in dollars \$64,553.00, \$49,152.00, and \$52,691.00, respectively (U.S. Census Bureau, 2012b). Finally, in 2011, out of approximately 117 million civilians aged 25 to 64 employed, about seven million were STEM occupants. Out of the seven million people employed in STEM occupations, minorities in STEM were only 6.4% Black and 6.5% Hispanic compared to 70.8% White and 14.5 Asian (U.S. Census Bureau, 2013).

The need for STEM workers has increased in the current global economy, in the nation, and in the nearest locality, especially among the minorities (Casey, 2012; DeJarnette, 2012). Many studies have shown that STEM innovation has been a main driver of US economic growth. The late 20th century led to huge progress in computer and information, and biomedical technologies.

Subsequently, to capture the economic benefits of the prevailing and unsubstantiated technologies in their entirety will need a pipeline of Americans equipped with STEM knowledge, skills, and abilities. In addition, the needs for STEM workers have increased even in other fields due to the dispersion of technology (Casey, 2012).

Literature indicated different minority STEM-related programs established in schools in order to equip students with respect to STEM majors (Flowers, 2009; Hansen & Gonzalez, 2014; Kendricks et al., 2013; Miller et al., 2011; Slovacek et al., 2011; Wyss et al., 2012). Kendricks et al. (2013) argued on minority student perception of the impact of mentoring on STEM disciplines, that students perceived mentoring as a contributor to their academic success in STEM areas. Kendricks et al., focused on the impact of mentoring on academic performance, but they did not report if the program or activity influenced them to major and graduate in STEM-related careers. Similarly, most researchers who studied STEM-related programs such as RISE, evaluated either the effectiveness of their various programs, activities in the programs, or the impact of the enrichment programs on program participants' retention, academic performance, major, and graduation (Almarode et al., 2014; Carter, Mandell, & Maton, 2009; Eagan et al., 2013; Fifolt, Engler, & Abbott, 2014; Jones, Barlow, & Villarejo, 2010; Kendricks et al., 2013; Kier, 2013; Maton, Sto Domingo, Stolle-McAllister, Zimmerman, & Hrabowski, 2009; Miyake et al., 2010; Slovacek et al., 2011; Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012). Yet, the aforementioned studies did not examine the relationship between minority students' participation in the RISE program and their decisions to majoring and graduating in STEM fields. Therefore, it is argued that there is a gap in the knowledge regarding the relationship between minority students' participation in the RISE program and their decisions to major and graduate in STEM-related fields.

1.2 Conceptual Framework

The science identity conceptual framework (Eagan et al., 2013) was used to understand how minority students' participation in the RISE, a STEM enrichment program, was related to participants' decisions to major and graduate in STEM fields (compared to non-participants or non-treated group).

1.2.1 Connection of key elements of the framework with STEM programs.

The key elements of science identity framework, (a) viewing identity from the science education scholars' way (i.e., social theory, the process of learning which is socialization of students into scientific norms and scientific terminology, and the pursuit for more equitable science education) and (b) from the science identity model (competence, performance, and recognition) (Carlone & Johnson, 2007), all depict that constructing social relationships is significant in increasing one's science identity. Next, each of the key elements of the framework is discussed and connected with STEM enrichment programs.

It has been argued that minority students were marginalized by science teaching and learning practices, engineering, and related careers (Aikenhead, 2011; Johnson, 2011; Lee, Quinn, & Valdes, 2013; Meyer & Crawford, 2011). Rahm (2014) argues that the cultural research of science education is still marginalized and dominated by the cultural difference model; science education fails often to consider the socio-historical and political positioning of students and institutions and programs. In addition, only a few minority students possess the relevant science norms and discourse practices of science; most of them lack the skills, especially the Hispanics (Eagan et al., 2013; Lee et al., 2013). Furthermore, there is still lack of equity in science education, and the traditional school science practices still persist (Johri & Olds, 2011; Penuel & Fishman, 2012). Additionally, minority students often lack the competence, performance, and the recognition as seen in the science identity model that is required in scientific fields. Literature shows that students of color are more likely to have more difficulty succeeding in undergraduate science than their white counterparts as they face interrelated and multilayered challenges (Beasley & Fischer, 2012; Carlone & Johnson, 2007; Espinosa, 2011; Hurtado et al., 2011; Johnson & Bozeman, 2012).

As a result, to help minority students in the aforementioned situations, RISE programs were established at institutions serving minorities. STEM enrichment programs, including RISE, have structured activities that provide students with essential supports and information that assist them, helping them navigate through STEM pathways. It is where minority students socialize to demonstrate science discourse and practice (Eagan et al., 2013), along with having competence, performance and recognition to be identified as scientists; it is an avenue that will break the bridge between the mainstreaming and marginalization and make science education more equitable than the traditional practices.

Therefore, as minority students participate in STEM enrichment programs, they socialize by connecting with faculty and advanced peers who give them access to professional networks. In addition, they have access to relevant information, resources from different institutions, workshops, presentations, and competitions to build their competence. More specifically, this is true for a study that used the RISE program to provide activities, including undergraduate research and professional development, to minority students. This allows them to be recognized as “science persons” by both their peers and the faculty; these allow them more science identities (Carlone & Johnson, 2007) than students who do not participate in the RISE program. In a related study conducted by Johnson and Bozeman (2012) on adopting an asset bundles model to support and improve minority students’ careers in academic medicine and the scientific pipeline, the results indicated that undergraduate research consisted of the specific sets of skills and resources individuals had to build on, that assisted them to succeed in academics and professional tasks.

2. What is a STEM Enrichment Program?

A STEM enrichment program is any program or treatment that is designed to inspire participants and reinforce in these participants the perception that they can pursue STEM-related careers (Supalo, Hill, & Larrick, 2014). STEM programs utilize various structures to accomplish the aforementioned goals. These include (a) using a friendship group that has a climate supportive of STEM where students socialize with academic goals (Robnett & Leaper, 2013), (b) a support group established to provide adequate social and academic support for the purpose of exposing students to STEM (Soares et al., 2013); and (c) an initiative established for improving STEM enrollment, retention, and graduation (Chang, Kwon, Stevens, & Buonora, 2016; Godin et al., 2015; Merolla & Serpe, 2013; Salto, Riggs, Delgado De Leon, Casiano, & De Leon, 2014; Wilson et al., 2012).

The STEM enrichment program investigated in this study is Research Initiative for Scientific Enhancement (RISE). There are numerous STEM enrichment programs. However, only few of them will be mentioned here. They are the Benjamin Banneker Scholars Program, Minority Opportunities in Research, McNair Program, Scholar Program, Meyerhoff Scholarship Program, Talent Search Program, remediation class, intervention class, supplemental class, some developmental classes, academic interaction, and some additional classes (Almarode et al., 2014; Carter et al., 2009; Eagan et al., 2013; Fifolt et al., 2014; Jones et al., 2010; Kendricks et al., 2013; Kier, 2013; Maton et al., 2009; Miyake et al., 2010; Slovacek et al., 2011; Soldner et al., 2012).

2.1 The Effectiveness of STEM Enrichment Program Activities

2.1.1 Mentoring. Mentoring, according to Slovacek et al. (2011), is when students are supported and advised by the faculty. Kendricks et al. (2013) examined the effectiveness of the Benjamin Banneker Scholars Program (BBSP). Results showed that mentoring was consistently rated as having the largest impact on their academic performance (Kendricks et al., 2013; Soldner et al., 2012). Some research studies (Jackson, 2013; Kendricks & Arment, 2011; Slovacek et al., 2011) found other activities more effective than mentoring in impacting students’ performance or decisions; although they still reported the effectiveness of mentoring. In the programs, many activities were employed to enhance students’ academic performance, which led to their graduation, and guided their entrance into PhD programs, along with their completing the PhD program in biomedical fields. Among the mentoring variables, the most significant predictors were having a mentor, receiving aid from that mentor in applying for graduate school, and having a faculty member who assisted in dealing with university issues. Similarly, the most significant research activity was taking part in communicating research to others (Slovacek et al., 2011). McGee, Saran, and Krulwich (2012) equally supported mentoring that impacts diversity by increasing scientific talents, particularly in underrepresented minorities.

2.1.2 Undergraduate Research. STEM support undergraduate research is done on campus in faculty-run labs. Jones et al. (2010) determined there was a relationship between timing and duration of undergraduate research involvement and college retention and academic performance in biological science. Jones et al. found that, in spite of differences among these students in previous accomplishments and demographic characteristics, undergraduate research is positively associated with odds of earning a bachelor’s degree, persevering in biology, and performing well in biology. Kendricks and Arment (2011) investigated the Scholar Program (SP) and found that among all the activities in this enrichment program, students ranked undergraduate research as having the greatest influence on professional preparedness for a STEM career and/or graduate study. Furthermore, undergraduate research participants were inclined to have enhanced academic performance, interest in a STEM PhD, interest in a STEM major, developed skills, and learning experience (Carter et al., 2009; Johnson & Bozeman, 2012; Maton et al., 2009; McGee et al., 2012; Shaw & Barbuti, 2010; Singer, 2013; Tyler-Wood et al., 2011).

2.1.3 Living-learning community. The effectiveness of the living-learning community was confirmed by Wawrzynski and Jessup-Anger (2010). They conducted a quantitative study and the results indicated that a student in a collaborative living-learning community is more likely to expect greater peer academic interactions as well as an enhanced academic environment. Findings indicated that students in living-learning environments experienced college differently as well. The students in collaborative living-learning communities were more likely to connect with their peers regarding academics and had more positive opinions about the benefit of their residence hall. Additionally, there were differences among the collaborative living-learning and combined living-learning community students, although they were hard to contrast directly (Wawrzynski & Jessup-Anger, 2010).

Whalen and Shelley (2010) found similar positive results about the living-learning community analysis revealed that the number of years students lived on-campus was significantly related with greater success, hence they were more likely to graduate or be retained by year six, which showed stronger academic capability of the STEM majors and students who participated in the learning community (which was available for STEM majors). Finally, Alkhasawneh and Hargraves (2014) concurred with the above studies about the effectiveness of the living-learning community in students' decisions to major in STEM fields. Results from the analyses of data showed the themes: The first themes that surfaced from the students' responses included the important role of family members, mostly parents, who played a part in impacting their decision to consider majoring in STEM (i.e., students' primary environment). Some students viewed their parents as role models and would try to follow their path and pursue a career in STEM fields. Relatives and acquaintances were another source of motivation as well. The second theme that surfaced was high skill in science and mathematics. The students expressed an understanding that STEM disciplines were appropriate with their career targets and abilities. To a smaller degree, students recognized the influence of high school teachers (Alkhasawneh & Hargraves, 2014). The overall results indicated that modeling retention for underrepresented minority students in STEM majors and analyzing main factors that influence student accomplishment, as well as understanding students' first year academic experience, could effectively build a learning environment and strategies that would lead students to the right path to success (Alkhasawneh & Hargraves, 2014).

3. Methodology

The treatment group, included students who were in STEM and non-STEM fields and were RISE program participants sometime within 14 years (from 2002 to 2016), while the control group were students in STEM and non-STEM fields, who did not participate in the RISE program. The participants were from equivalent cohorts of an HBCU in the south east. There were 114 students in the treatment group and 280 students in the control group. This number of students in the control group were used in order to find a good match for each student in the treatment group. Thus, there was a total of 394 students from different classifications such as sophomore, junior, senior, and graduate students from minority races – African American, Indian American, and Hispanics. The participants' age range was from 18 years and above. They were male and female students.

3.1 Procedures for recruitment and participation. Participants were recruited from the RISE program known as Research Initiative for Scientific Enhancement (RISE, 2016). Most participants were recruited in the program during that time, based on their STEM interest and willingness to participate in research, although a few non-STEM majors were also recruited. Participation in the RISE program is by self-selection/voluntary. Several criteria were used to recruit participants: (a) student must complete an application and provide three letters of recommendation, official transcript(s), personal statement, and state application; (b) student must be a full-time student; (c) they must be a sophomore as of fall semester; (d) they must apply with a minimum GPA of 2.8; (e) they must have declared their major in biology, chemistry, or psychology; (f) they must be a US citizen, US national or permanent resident; and (g) they must be African American, Hispanic, Indian American (FSU-RISE, 2012). In this study, students who had graduated were included as participants to ensure an adequate sample size to obtain a reliable regression model and to assume that coefficients of the predictors were from a normally distributed sampling distribution due to the central limit theorem. This led to realizing a valid confidence interval and significance test (Field, 2013).

3.2 Data Analysis

3.2.1 Research questions. Two research questions guided this study:

1. Is there a relationship between students' participation in the RISE program activities and their decided STEM majors as compared to non-program participants?

2. Is there a relationship between students' participation in the RISE program activities and their STEM graduates as compared to non-program participants?

In research question one, the dependent variable was students' decided STEM majors (1 = STEM major; 0 = non-STEM major) and in research question two, the dependent variable was STEM graduates (1 = STEM Graduate; 0 = non-STEM Graduate). The Average Treatment effect on the Treated (ATET), a particular form of logistic regression, was computed using the `teffects` command in order to compute the average treatment effect (of participating in the RISE program) on the participants in their decisions to major and graduate in STEM compared to non-program participants (Austin, 2011; Stata, 2015).

3.2.2. Variables. Both dependent and covariates are represented in tables 1 and 2 below.

Table 1
Dependent Variables

Research Question	Dependent Variable	Measurement
Student decided to be a STEM major	STEM majors	Binary, 1 = yes, 0 = no
A STEM Graduate	STEM graduates	Binary, 1 = yes, 0 = no

Table 2
Covariates for Propensity Score Matching

Covariate	Measurement
Gender	Binary, 1 = male, 0 = female
Social Economics Status	An EFC below \$785, less than 25th percentile, = 1, else = 0
Parental education level	0 = college degree, 1 = first generation
Previous Educational Achievement	0 = Prior college, 1 = first college
Race	0 = for all other students not of that race, 1 = Black, Hispanic or Native American

Some covariates (high school GPA, SAT, AP grades, and ACT) were intended to be utilized for propensity score matching. However, it was determined due to missing or incomplete data that the only covariates that were used are those in Table 2 above.

4. RESULTS

4.1 Descriptive Statistics

The participants in the study were 394 STEM and non-STEM students comprised of 114 RISE program scholars, the treatment or treated group, and 280 in the control group. The males were 147 in number, while the females were 259. Tables 3a, 3b and 3c are the summary of the descriptive statistics for the variables utilized in this study: STEM major and graduate/non-STEM major and -graduate (combined), race, prior college (for previous educational achievement), parental education, and treated (RISE program participants)/non treated (non-RISE program participants). The Black participants were greater in number than other races, followed by the Hispanics, and lastly, the Indian Americans (See Table 3a, 3b, and 3c). In addition, the Tables showed that Indian Americans and Hispanic male participants majored and graduated more than the black ($M = 1.00$; $SD = 0.000$) and ($M = 1.00$; $SD = 0.000$), respectively. Among all races, male participants majored and graduated more than female participants (See Table 3a, 3b, and 3c).

The female in the Indian Americans students majored and graduated most among the females in other races ($M = 0.89$; $SD = 0.333$), followed by the Hispanics female ($M = 0.88$; $SD = 0.332$) and lastly, the black female ($M = 0.85$; $SD = 0.354$).

Table 3a

Descriptive Statistics on Variables of Black Race by Gender

Group	Race	Gender	N	M	SD
Black					
STEM majors or graduates/non-STEM majors or -graduates		M	119	0.88	0.323
		F	225	0.85	0.354
Prior College		M	108	0.77	0.424
		F	208	0.72	0.450
Parental Education		M	119	0.37	0.485
		F	225	0.43	0.496
Treated (RISE program participants)/ non-Treated (non-RISE)		M	119	0.29	0.458
		F	225	.025	0.436
Expected Family Contribution (EFC)		M	119	0.504	0.502
		F	225	0.476	0.501

Note. Due to missing data the numbers above vary across research question; parental education is 0 = college education, 1 = first generation; previous educational achievement is 0 = prior college and 1 = first college; STEM majors or graduates = 1 and non-STEM majors or -graduates = 0; RISE program participants = 1 and non-RISE program participants = 0; and for EFC see Table 2.

Table 3b

Descriptive Statistics on Variables of Hispanic Race by Gender

Group	Race	Gender	N	M	SD
Hispanic					
STEM majors or graduates = 1/non-STEM majors or -graduates = 0		M	14	1.00	0.000
		F	25	0.88	0.332
Prior College		M	13	0.54	0.519
		F	23	0.48	0.511
Parental Education		M	14	0.36	0.497
		F	25	0.32	0.476
Treated (RISE program participants)/non-Treated (non-RISE)		M	14	0.07	0.267
		F	25	0.28	0.458
Expected Family Contribution (EFC)		M	14	0.500	0.519
		F	25	0.600	0.500

Note. Due to missing data the numbers above vary across research question. For the definitions of the above variables, see Table 3a.

Table 3c

Descriptive Statistics on Variables of Native American Race by Gender

Group	Race	Gender	N	M	SD
Indian American					
STEM majors or graduates = 1/non-STEM majors or -graduates = 0		M	2	1.00	0.000
		F	9	0.89	0.333
Prior College		M	2	0.50	0.707
		F	9	0.67	0.500
Parental Education		M	2	0.50	0.497
		F	9	0.56	0.527
Treated (RISE program participants)/non-Treated (non-RISE)		M	2	0.00	0.000
		F	9	0.22	0.441
Expected Family Contribution (EFC)		M	2	0.500	0.707
		F	9	0.222	0.441

Note. Due to missing data the numbers above vary across research question. For the definitions of the above variables, see Table 3a.

Table 4 below is the summary of the descriptive statistics for RISE program participants' and non-RISE program participants' STEM majors and STEM graduates variables. In Table 4, the gap that RISE created in majoring and graduation in STEM was made plain. This table depicts means in these variables, which showed the magnitude of the benefit of RISE. For the "STEM majors" variable, non-RISE students major about 85% in STEM disciplines, while RISE students major about 92%; the 7% difference is important to produce more STEM students. For the "STEM graduates" variable, also, non-RISE students graduate about 79% in STEM disciplines, while RISE students graduate about 91%; the 12% difference is also important to produce more STEM graduates. These differences are similar to the percentages predicted as the odds of majoring and graduating in STEM disciplines.

Table 4

Descriptive Statistics on Dependent Variables

Group	mN	M	SD
Non-Treated or Non-RISE program participants			
Variables			
STEM Majors	312	0.85	0.349
STEM Graduates	199	0.79	0.409
Treated or RISE program participants			
Variables			
STEM Majors	106	0.92	0.265
STEM Graduates	80	0.91	0.284

Note. Due to missing data the numbers above vary across research question. STEM majors = 1; non-STEM majors = 0; STEM graduates = 1; and non-STEM graduates = 0.

4.2 Question one. Research question one was established to ascertain if there was a relationship between students' participation in the RISE program activities and their decided STEM majors as compared to non-participants. To respond to this research question, the STEM major or non-STEM major data were analyzed separately, using Stata for an Average Treatment Effect on the Treated (ATET) logistic regression model following the `teffects` command where propensity score was matched on gender, EFC, prior college, race, and parental education. A one-to-one matching process was employed. Students who participated in the RISE program (the treated or the treatment group) were matched one-to-one with the non-treated or the control group.

Table 5

The relationship between participation in RISE program and decided STEM major or non-STEM major

STEM majors							95% Confidence Interval	
	Coefficient (Odds Ratio)	AI Std Err	Robust	z	P> z	Upper CI	Lower CI	
RISE participants	0.071 (1.07)	0.033		2.15	0.032	0.006	0.137	

Data in Table 5 reveal that RISE program participants have statistically significant odds ratios of 1.07 of majoring in STEM-related careers than the non-RISE participants. In other words, for the RISE program participants, the odds of majoring in STEM-related careers are 1.07 times larger than the odds for non-RISE program participants. That means RISE scholars major about 7% more often than their counterparts.

4.2.1 Question two. Research question two was established to ascertain if there was a relationship between students' participation in the RISE program activities and their STEM graduates as compared to non-participants. To respond to this research question, the STEM graduate or non-STEM graduate data were analyzed separately, using Stata for an Average Treatment Effect on the Treated (ATET) logistic regression model following the `teffects` command where propensity score was matched on gender, EFC, prior college, race, and parental education. A one-to-one matching process was employed. Students who participated in the RISE program (the treated or the treatment group) were matched one-to-one with the non-treated or the control group.

Table 6

The relationship between participation in RISE program and STEM graduate or non-STEM graduate

STEM graduates							95% Confidence Interval	
	Coefficient (Odds Ratio)	AI Std Err	Robust	z	P> z	Upper CI	Lower CI	
RISE participants	0.113 (1.12)	0.047		2.40	0.017	0.021	0.205	

Data in Table 6 reveal that RISE program participants have statistically significant odds ratios of 1.12 of graduating in STEM-related careers than the non-RISE participants. In other words, for the RISE program participants, the odds of graduating in STEM-related careers are 1.12 times larger than the odds for non-RISE program participants. That means RISE scholars major and graduate about 12% more often than their counterparts.

5. DISCUSSION

5.1 Summary

The study revealed that for the two questions, participating in the RISE program was associated with improved academic achievement.

5.1.1 Question One. The results demonstrated that RISE program students major about 7% more often than non-RISE program students - with the result being significant. That is, students who participated in the RISE program were predicted to have at least 7% greater odds of majoring in STEM disciplines compared to students who did not participate in RISE, with the effect between 1% and 15%.

5.1.2 Question Two. The results demonstrated that RISE program students graduate about 12% more often than non-RISE program students - with the result being significant. That is, students who participated in the RISE program were predicted to have at least 12% greater odds of graduating in STEM disciplines compared to non-RISE program participants, with the effect between 2% and 22%.

5.2 Interpretation

First, this study intended to verify if participation in the Research Initiative for Scientific Enhancement (RISE) program was related to participants' decisions to major in STEM-related careers, which was posed in research question one. On the average, RISE program students major 7% more often in STEM-related disciplines than non-RISE program students.

Additionally, this study intended to verify if participation in the Research Initiative for Scientific Enhancement (RISE) program was related to participants' graduating in STEM-related careers, which was posed in research question two. On the average, RISE program students graduate about 12% more often from STEM-related disciplines than non-RISE program students.

These significant results imply that attending the RISE program is related to majoring and graduating in STEM careers. That means students' participation in the RISE program could lead to enhanced STEM graduates. This could also mean: more RISE programs equals more STEM graduates, or more students in RISE programs equals more STEM graduates.

As mentioned earlier, RISE program participants performed different activities which contributed to the desired outcomes found in this study. As stated earlier in this study, the RISE program has structured educational pipeline activities leading participants to graduate schools, such as hands-on biotechniques or biopsychology workshops, enrichment seminars, faculty-mentored intramural and extramural research, scientific communications and interdisciplinary research courses, local and national research symposia and conferences, and complete Graduate Record Examination (GRE) preparatory workshops.

The results from this study and others support the notion that STEM programs demonstrate a positive effect on students. Again, these are programs created in schools and organizations for recruiting, retention, educating, and graduating students; students perform different activities, including mentoring, living-learning community, STEM video, project-based/hands-on activities, tutoring, supplementary instruction, professional workshop and graduate school visit, and GRE workshop (Almarode et al., 2014; Jackson, 2013; Kendricks et al., 2013; Kier, 2013; Maton et al., 2009; Miyake et al., 2010; Slovacek et al., 2011; Soldner et al., 2012).

5.3 Implications

The U.S. Census Bureau projected that racial and ethnic minorities are expected to be more than one-half of the national population by 2050. As yet, relatively low rates of success among minority students in STEM education persist. Therefore, understanding how to maximize success among racial and ethnic minorities in STEM education is very important. This study has the potential to support the continued efforts to improve society at large, organizations, schools, families, and individuals, given the importance of technology in the current global economy, technology is a main driver of US economic growth, and minority students are underrepresented in STEM-related disciplines, hence, in STEM jobs. The results of this study are consistent with previous research on STEM programs, that participation in RISE appears to be related to improved academic outcomes.

Programs such as the RISE program that combine these activities (i.e., mentoring, undergraduate research, etc.) appear to have the potential to support student success. This implies that a) if a school is implementing STEM goals, it is suggested that programs similar to the RISE program be considered as part of the STEM program, b) programs such as RISE that combine several activities, should be studied to determine what aspects of the program were beneficial and how, from a participant's perspective, and c) since the STEM program is such an important initiative, the RISE program and other similar programs are worthy of continued financial and academic support, as this study shows. They have the potential to produce positive outcomes.

That is, programs that influence the participants' decisions towards majoring and graduating in STEM-related disciplines should be established. While shown as positive, social injustice issues remain and according to Funk and Parker (January 9, 2018) many blacks are concerned about racial discrimination in STEM fields. This information will motivate educational leaders to write more grants and encourage students to connect with the RISE program. This will transform the students, families, schools, and the society, however to fully realize the potential of such programs the perceptions and realities of blacks and other minorities in STEM areas needs to be fully addressed in unison with these academic initiatives.

5.4 Conclusion

Administrators exploring ways to support STEM academic success of students should consider programs such as RISE or other similar programs, as these have demonstrated the potential to improve certain outcomes. Participating in the RISE program could be helpful to minority students as it has been shown that many students of color have more difficulty thriving in undergraduate science than their white counterparts (Beasley & Fischer, 2012; Carlone & Johnson, 2007; Espinosa, 2011; Hurtado et al., 2011; Johnson & Bozeman, 2012). Consequently, to benefit minority students in STEM, it is suggested that programs like RISE may effectively support black student participation in STEM related fields.

Based on the results from this study, and if the results from an additional study are found to be positive, it could support the conclusion that RISE programs, especially the one utilized in this study, are effective in influencing participants' decisions to major and graduate in STEM-related fields. Furthermore, this could increase the enrollment, retention, and graduation of minorities in STEM fields, thereby increasing the number of minorities in STEM jobs. Then, it is recommended that more RISE programs should be established in schools to ensure more minorities major and graduate in STEM-related fields.

References

- Ackerman, P. L., Kanfer, R., & Beier, M. E. (2013). Trait complex, cognitive ability, and domain knowledge predictors of baccalaureate success, STEM persistence, and gender differences. *Journal of Educational Psychology, 105*(3), 911-927. doi:10.1037/a0032338
- Adolino, J. R., & Blake, C. H. (2011). *Comparing public policies: Issues and choices in industrialized countries*. (2nd ed.). Washington, DC: CQ Press.
- Aikenhead, G. (2011). Towards a cultural view on quality science teaching. In *the professional knowledge base of science teaching* (pp. 107-127). Retrieved from <https://www.usask.ca/education/profiles/aikenhead/webpage/Towards-a-Cultural-View.pdf>
- Alkhasawneh, R., & Hargraves, R. H. (2014). Developing a hybrid model to predict student first year retention in STEM disciplines using machine learning techniques. *Journal of STEM Education, 15*(3), 35-42.
- Almarode, J. T., Subotnik, R. F., Crowe, E., Tai, R. H., Lee, G. M., & Nowlin, F. (2014). Specialized high school and Talent Search Programs: Incubators for adolescents with high ability in STEM disciplines. *Journal of Advanced Academics, 25*(3), 307-331. doi:
- Austin, P. C. (2011). An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research, 46*, 399-424. doi: 10.1080/00273171.2011.568786
- Beasley, M. A., & Fischer, M. J. (2012). Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math, and engineering majors. *Social Psychology Education, 15*, 427-448. doi: 10.1007/s11218-012-9185-3
- Bidwell, A. (February 24, 2015). STEM Workforce No More Diverse Than 14 Years Ago. U.S. News and World Report. Retrieved from <https://www.usnews.com/news/stem-solutions/articles/2015/02/24/stem-workforce-no-more-diverse-than-14-years-ago>
- Bright, M. (2013, March 22). *Low-Income and Minority Students Needed in STEM Pipeline* [Blog post]. Retrieved from http://www.huffingtonpost.com/marcus-bright/lowincome-and-minority-st_b_2920675.html
- Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187-1218. doi: 10.1002/tea.20237
- Carter, F., Mandell, M., & Maton, K. (2009). The influence of on-campus, academic year undergraduate research on STEM Ph.D. outcomes: Evidence from the Meyerhoff Scholarship Program [Abstract]. *Educational Evaluation and Policy Analysis, 31*(4), 441-462. doi: 10.3102/0162373709348584
- Casey, B. (2012). *STEM education: Preparing for the jobs of the future*. Retrieved from Government Printing Office http://www.jec.senate.gov/public/_cache/files/6aaa7e1f-9586-47be-82e7-326f47658320/stem-education---preparing-for-the-jobs-of-the-future-.pdf
- Chang, J., Kwon, C., Stevens, L., & Buonora, P. (2016). Strategies to recruit and retain students in physical sciences and mathematics on a diverse college campus. *Journal of College Science Teaching, 45*(3), 14-22.
- Charleston, L. J. (2012). A qualitative investigation of African Americans' decision to pursue computing science degrees: Implications for cultivating career choice and aspiration. *Journal of Diversity in Higher Education, 5*(4), 222-243. doi: 10.1037/a0028918
- DeJarnette, N. K. (2012). America's children: Providing early exposure to STEM (science, technology, engineering and math) initiatives. *Education, 133*(1), 77-84.
- Eagan, Jr., M. K., Hurtado, S., Chang, M. J., Garcia, G. A., Herrera, F. A., & Garibay, J. C. (2013). Making a difference in science education: The impact of undergraduate research programs. *American Educational Research Journal, 50*(4), 683-713. doi: 10.3102/0002831213482038
- Espinosa, L. L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review, 81*(2), 209-388.
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. (4th ed.). Thousand Oaks, CA: Sage.

- Fifolt, M., Engler, J., & Abbott, G. (2014). Bridging STEM professions for McNair Scholars through faculty mentoring and academic preparation. *College and University*, 89(3), 24-33.
- Flowers, R. D. (2009). *After-school enrichment and the activity theory: How can a management service organization assist schools with reducing the achievement gap among minority and non-minority students in science, technology, engineering, and mathematics (STEM) during the after-school hours*. Retrieved from ProQuest Digital Dissertations. (AAT 3295214)
- Funk, C & Parker, K. (January 9, 2018). Blacks in STEM jobs are especially concerned about diversity and discrimination in the workplace. Pew Research Center. Retrieved from <https://www.pewsocialtrends.org/2018/01/09/blacks-in-stem-jobs-are-especially-concerned-about-diversity-and-discrimination-in-the-workplace/>
- FSU-RISE. (2012, January 9). *Terms for acceptance into the FSU-RISE program*. Retrieved from <http://www.uncfosu.edu/Documents/fsurise/FSU-RISE-Program-Overview.pdf>
- Godin, E. A., Wormington, S. V., Perez, T., Barger, M. M., Synder, K. E., Richman, L. S., Schwartx-Bloom, R., & Linnenbrink-Garcia, L. (2015). A pharmacology-based enrichment program for undergraduates promotes interest in science. *Life Science Education*, 14, 1-12. doi: 10.1187/cbe.15-02-0043
- Hansen, M., & Gonzalez, T. (2014). Investigating the relationship between STEM learning principles and student achievement in math and science. *American Journal of Education*, 120(2), 139-171. doi: 10.1086/674376
- Hurtado, S., Eagan, M. K., Tran, M. C., Newman, C. B., Chang, M. J., & Velasco, P. (2011). "We do science here": Underrepresented students' interactions with faculty in different college contexts. *Journal of Social Issues*, 67(3), 553-579. doi: 10.1111/j.1540-4560.2011.01714.x
- Jackson, D. L. (2013). A balancing act: Impacting and initiating the success of African American female community college transfer students in STEM into the HBCU environment. *The Journal of Negro Education*, 82(3), 255-271. doi:10.7709/jnegroeducation.82.3.0255
- Johnson, C. C. (2011). The road to culturally relevant science: Exploring how teachers navigate change in pedagogy. *Journal of Research in Science Teaching*, 48(2), 170-198. doi: 10.1002/tea.20405
- Johnson, J., & Bozeman, B. (2012). Perspective: Adopting an asset bundle model to support and advance minority students' careers in academic medicine and the scientific pipeline. *Academic Medicine*, 87(11), 1488-1495. doi: 10.1097/ACM.0b013e31826d5a8d
- Johri, A., & Olds, B. M. (2011). Situated engineering learning: Bridging engineering education research and the learning sciences. *Journal of Engineering Education*, 100(1), 151-185.
- Jones, M. T., Barlow, A. E. L., & Villarejo, M. (2010). Importance of undergraduate research for minority persistence and achievement in biology. *The Journal of Higher Education*, 81(1), 82-115. doi: 10.1353/jhe.0.0082
- Kendricks, K. D., & Arment, A. R. (2011). Adopting a K-12 family model with undergraduate research to enhance STEM persistence and achievement in underrepresented minority students. *Journal of College Science Teaching*, 41(2), 22-28.
- Kendricks, K. D., Nedunuri, K.V., & Arment, A. R. (2013). Minority student perceptions of the impact of mentoring to enhance academic performance in STEM disciplines. *Journal of STEM Education*, 14(2), 38-46.
- Kier, M. W. (2013). *Examining the effects of a STEM careers video intervention on the interests and STEM professional identities of rural, minority middles school students*. Retrieved from ProQuest Digital Dissertations. (AAT 3295214)
- Lee, O., Quinn, H., & Valdes, G. (2013). Science and language for english language learners in relation to next generation science standards and with implications for common core state standards for english language arts and mathematics. *Educational Researcher*, XX(X), 1-11. doi: 10.3102/0013189X13480524
- Martella, R. C., Nelson, J. R., Morgan, R. L., & Marchand-Martella, N. E. (2013). *Understanding and interpreting educational research*. New York, NY: Guilford Press.
- Maton, K. I., Sto Domingo, M. R., Stolle-McAllister, K. E., Zimmerman, J. L., & Hrabowski, III, F. A. (2009). Enhancing the number of African-Americans who pursue STEM PhDs: Meyerhoff scholarship program outcomes, processes, and individual predictors. *Journal of Women and Minorities in Science and Engineering*, 15(1), 15-37. doi: 10.1615/JWomenMinorScienEng.v15.i1.20

- McGee, R., Jr., Saran, S., & Krulwich, T. A. (2012). Diversity in the biomedical research workforce: Developing talent. *Mt Sinai Journal of Medicine*, 79(3), 397-411. doi: 10.1002/msj.21310
- McGlynn, A. P. (2009). Needed: More – and more diverse – STEM students & STEM teachers [Abstract]. *The Hispanic Outlook in Higher Education*, 20(1), 20-22.
- Melguizo, T., & Wolniak, G. C. (2011). The earnings benefits of majoring in STEM fields among high achieving minority students. *Research in Higher Education*, 53(4), 383-405. doi: 10.1007/s11162-011-9238-z
- Merolla, D. M., & Serpe, R. T. (2013). STEM enrichment programs and graduate school matriculation: The role of science identity salience. *Social Psychology of Education*, 16(4), 575-597. doi: 10.1007/s11218-013-9233-7
- Meyer, X., & Crawford, B. A. (2011). Teaching science as a cultural way of knowing: Merging authentic inquiry, nature of science, and multicultural strategies. *Cultural Studies of Science Education*, 6(3), 525-547. doi: 10.1007/s11422-011-9318-6
- Miller, L. M., Chang, C., Wang, S., Beier, M. E., & Klisch, Y. (2011). Learning and motivational impacts of a multimedia science game. *Computer & Education*, 57(1), 1425-1433. doi:10.1016/j.compedu.2011.01.016
- Miyake, A., Kost-Smith, L. E., Finkelstein, N. D., Pollock, S. J., Cohen, G. L., & Ito, T. A. (2010). Reducing the gender achievement gap in college science: A classroom study of values affirmation [Abstract]. *Science*, 330, 1234-1237. doi: 10.1126/science.1195996
- Museum, S., Palmer, R. T., Davis, R. J., & Maramba, D. C. (2011). *Racial and ethnic minority students' success in STEM education* [Abstract]. Hoboken, NJ: Jossey-Bass. Retrieved from http://works.bepress.com/robert_palmer/32
- NC State Engineering. (2014, June). Questions for Angelitha Daniel. *North Carolina State University College of Engineering, Raleigh*, 2-4.
- Penuel, W. R., & Fishman, B. J. (2012). Position paper: Large-scale science education intervention research we can use. *Journal of Research in Science Teaching*, 49(3), 281-304. doi: 10.1002/tea.21001
- Rahm, J. (2014). Reframing research on informal teaching and learning in science: Comments and commentary at the heart of a new vision for the field. *Journal of Research in Science Teaching*, 1-13. doi: 10.1002/tea.21141
- RISE (2016). *The program*. Retrieved from <http://www.uncfsu.edu/fsurise/program>
<http://genderandset.open.ac.uk/index.php/genderandset/article/viewFile/299/521>
- Robnett, R. D., & Leaper, C. (2013). Friendship groups, personal motivation, and gender in relation to high school students' STEM career interest. *Journal of Research on Adolescence*, 23(4), 652-664. doi: 10.1111/jora.12013
- Salto, L. M., Riggs, M. L., Delgado De Leon, D., Casiano, C. A., & De Leon, M. (2014). Underrepresented minority high school and college students report STEM-pipeline sustaining gains after participating in the Loma Linda University summer health disparities research program. *PLOS ONE* 9(9), 1-14. doi:10.1371/journal.pone.0108497
- Shaw, E. J., & Barbuti, S. (2010). Patterns of persistence in intended college major with a focus on STEM majors. *NACADA Journal*, 30(2), 19-34.
- Siebens, J. & Ryan, C. L. (2012). Field of bachelor's degree in the United States: 2009. In U.S. Census Bureau (Ed.), *American Community Survey Reports* (p.18). Retrieved from <http://www.census.gov/prod/2012pubs/acs-18.pdf>
- Singer, S. R. (2013). Advance research on undergraduate science learning. *Journal of Research in Science Teaching*, 50(6), 768-772. doi: 10.1002/tea.21098
- Slovacek, S. P., Peterfreund, A. R., Kuehn, G. D., Whittinghill, J. C., Tucker, S., Rath, K. A., & Reinke, Y. G. (2011). Minority students severely underrepresented in science, technology engineering and math. *Journal of STEM Education: Innovations and Research*, 12(1), 5-16.
- Soares, A. J., Muhammad, R., Kobelo, D., Bellarmine, G. T., Li, C., & Siddiqui, S. A. (2013). Implementation of a STEM summer enrichment program in a low income community [Abstract]. *American Society for Engineering Education*, 1-11.

- Soldner, M., Rowan-Kenyon, H., Inkelas, K. K., Garvey, J., & Robbins, C. (2012). Supporting students' intentions to persist in STEM disciplines: The role of living-learning programs among other social-cognitive factors. *The Journal of Higher Education*, 83(3), 311-336. doi: 10.1353/jhe.2012.0017
- Stata. (2015). *Stata User's guide: Release 14*. Retrieved from <http://www.stata.com/manuals14/u.pdf>
- Sundgot-Borgen, J., & Garthe, I. (2011). Elite athletes in aesthetic and olympic weight class sports and the challenge of body weight and body composition. *Journal of Sports Sciences*, 29(1), 101-114. doi:10.1080/02640414.2011.565783.
- Supalo, C. A., Hill, A. A., & Larrick, C. G. (2014). Summer enrichment programs to foster interest in STEM education for students with blindness or low vision. *Journal of Chemical Education*, 91(8), 1257-1260. doi: 10.1021/ed400585v
- Thelin, J. R. (2004). *A history of American higher education*. Baltimore, MD: John Hopkins Press.
- Thompson, S. K. (2012). *Sampling*. Retrieved from <http://site.ebrary.com/lib/fayetteville/reader.action?docID=10630536>
- Tyler-Wood, T., Ellison, A., Lim, O., & Periathiruvadi, S. (2011). Bringing Up Girls in Science (BUGS): The effectiveness of an afterschool environmental science program for increasing female students' interest in science careers. *Journal of Science Education and Technology*, 21(1), 46-55. doi: 10.1007/s10956-011-9279-2
- U.S. Census Bureau. (2012a). Table 1: Educational attainment for the population 25 years and over by age, sex, race, and Hispanic origin, and nativity status: 2009. In U.S. Census Bureau (Ed.), *Population Characteristics* (p.7). Retrieved from <http://www.census.gov/prod/2012pubs/p20-566.pdf>
- U.S. Census Bureau. (2013). Table 3: Employment in STEM occupations: 2011. In U.S. Census Bureau (Ed.), *American Community Survey Reports* (p.7). Retrieved from <http://www.census.gov/prod/2013pubs/acs-24.pdf>
- U.S. Census Bureau. (2012b). Table 6: Median Earnings by field of bachelor's degree, sex, race, and Hispanic origin for full-time, year-round workers 25 years and over: 2009. In U.S. Census Bureau (Ed.), *American Community Survey Reports* (p.18). Retrieved from <http://www.census.gov/prod/2012pubs/acs-18.pdf>
- Wang, M. -T., Eccles, J. S., & Kenny, S. (2013). Not lack of ability but more choice: Individual and gender differences in choice of careers in science, technology, engineering, and mathematics. *Psychological Science*, 24(5), 770-775. doi: 10.1177/0956797612458937
- Wang, X. (2013). Why student choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal*, 50(5), 1081-1121. doi: 10.3102/0002831213488622
- Wawrzynski, M. R., & Jessup-Anger, J. E. (2010). From expectations to experiences: Using a structural typology to understand first-year student outcomes in academically based living-learning communities. *Journal of College Student Development*, 51(2), 201-217.
- Whalen, D. F., & Shelley, M. C., II. (2010). Academic success for STEM and non-STEM majors. *Journal of STEM Education*, 11(1/2), 45 - 60.
- Wilson, Z. S., Holmes, L., deGravelles, K., Sylvain, M. R., Batiste, L., Johnson, M., McGuire, S. Y., Pang, S. S., & Warner, I. M. (2012). Hierarchical mentoring: A transformative strategy for improving diversity and retention in undergraduate STEM disciplines. *Journal of Science Education and Technology*, 21(1), 148-156. doi: 10.1007/s10956-011-9292-5
- Wyss, V. L., Heulskamp D., & Siebert, C. J. (2012). Increasing middle school student interest in STEM careers with videos of scientists. *International Journal of Environmental & Science Education*, 7(4), 501-522.