FAMILY MATTERS: FAMILIAL SUPPORT AND SCIENCE IDENTITY FORMATION FOR AFRICAN AMERICAN FEMALE STEM MAJORS

by

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ABSTRACT

ASHLEY DAWN PARKER. Family Matters: Familial support and science identity formation for African American female STEM majors.
(Under the direction of DR. ROSLYN A. MICKELSON)

This research seeks to understand the experiences of African American female undergraduates in STEM. It investigates how familial factors and science identity formation characteristics influence persistence in STEM while considering the duality of African American women's status in society. This phenomenological study was designed using critical race feminism as the theoretical framework to answer the following questions: 1) What role does family play in the experiences of African American women undergraduate STEM majors who attended two universities in the UNC system? 2) What factors impact the formation of science identity for African American women undergraduate STEM majors who attended two universities in the UNC system?

Purposive sampling was used to select the participants for this study. The researcher conducted in-depth interviews with 10 African American female undergraduate STEM major from a predominantly White and a historically Black institution with the state of North Carolina public university system. Findings suggest that African American families and science identity formation influence the STEM experiences of the African American females interviewed in this study. The following five themes emerged from the findings: (1) independence, (2) support, (3) pressure to succeed, (4) adaptations, and (5) race and gender.

This study contributes to the literature on African American female students in STEM higher education. The findings of this study produced knowledge regarding

policies and practices that can lead to greater academic success and persistence of African American females in higher education in general, and STEM majors in particular. Colleges and universities may benefit from the findings of this study in a way that allows them to develop and sustain programs and policies that attend to the particular concerns and needs of African American women on their campuses. Finally, this research informs both current and future African American female STEM students so that they might benefit from the knowledge of the experiences of others in STEM-related fields. As a result, other African American female students might be enlightened by these stories and have the confidence to pursue a STEM degree of their own.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

Statement of the Problem

In an increasingly globalized world, scientific development and innovation are fundamentally important for sustaining economic competitiveness, national security, and quality of life for American citizens. Improving recruitment and retention of students in STEM fields are critical challenges facing the nation (Ong, Wright, Espinosa, & Orfield, 2011). STEM fields are inextricably linked to national economic prosperity and innovation, capturing the attention in recent years of a struggling American economic market (National Academy of Sciences, 2007; Riegle-Crumb & King, 2010). Subsequently, the past decade has witnessed a renewed focus on STEM education comparable to the frenzy that accompanied the launch of Sputnik in the late 1950s (Riegle-Crumb et al., 2012).

A considerable amount of the current conversation surrounding STEM includes discussion about the relative absence of women and minorities in various STEM-related jobs (National Academy of Sciences, 2007). Historically, STEM fields have been occupied by White and Asian males, leaving all females and male minority group members less likely to enter into these occupational sectors (Campbell, Denes, & Morrison, 2000). Despite the advancement of women and minorities over the past several decades (i.e. increased college enrollment and conferred STEM degrees) and the increasing demands of a rapidly evolving technological society, those trained and

employed in STEM fields remain overwhelmingly White and male (Freeman , 2004; National Science Foundation, 2007). The inequality is most pronounced for minority women and women from economically disadvantaged backgrounds (NAS, 2006).

The number of students who graduate with degrees in STEM directly influences the number of individuals employed in STEM-related fields. Table 1.1 reviews the trends in the number of STEM degrees conferred for students age 18-24 from 2001-2010. The data shows that overall White men and women are heavily represented in agricultural (39.55% and 41.45%) and biological (25.92% and 35.18) sciences and mathematics (39.90% and 30.71%), respectively. In fact, White women outnumber White men in both biological and agricultural sciences, a trend which has shifted in agricultural sciences from 2001-2010. White and Asian males are well represented in computer sciences and engineering majors while other minority male groups and women are not. Tentatively, conclusions can be drawn from this data which suggest that STEM fields are overwhelmingly White and male with the exception of White females in agricultural and biological sciences.

Table 1.1

Science and Engineering Bachelor's Degrees awarded in 2010 to US Citizens and permanent residents, by race/ethnicity and gender

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agricultural Sciences										
White Men	45.47	44.15	43.07	42.80	42.85	42.17	42.59	41.36	41.08	39.55
African American Men	0.97	1.05	1.12	1.00	1.05	1.10	1.07	1.30	1.23	1.21
Asian American/Pacific Islander Men	0.83	0.94	1.02	0.89	0.90	1.20	1.29	1.41	1.52	1.54
Hispanic Men	1.73	1.78	1.72	1.75	1.75	1.50	1.88	2.17	2.08	2.12
American Indian/Alaska Native Men	0.69	0.52	0.41	0.59	0.47	0.49	0.48	0.45	0.54	0.47
Unknown Men	1.76	1.92	2.11	1.96	2.06	2.12	2.48	2.15	2.44	2.67
White Women	41.35	41.99	42.60	42.69	42.35	42.26	40.81	40.87	40.77	41.45
African American Women	1.52	1.61	1.47	1.68	1.58	1.74	1.69	1.75	1.47	1.75
Asian American/Pacific Islander Women	1.49	1.46	1.62	1.58	1.76	1.98	2.19	2.06	2.34	2.60
Hispanic Women	1.80	2.09	2.21	2.26	2.47	2.32	2.58	3.29	3.05	2.85
American Indian/Alaska Native Women	0.56	0.40	0.52	0.53	0.49	0.60	0.47	0.49	0.56	0.40
Unknown Women	1.84	2.08	2.12	2.28	2.27	2.51	2.48	2.70	2.94	3.40
Biological Sciences										
White Men	28.09	27.46	26.29	26.25	26.19	26.15	26.57	26.18	26.01	25.92
African American Men	2.19	2.12	2.08	2.09	1.96	1.97	2.02	2.03	2.07	2.22
Asian American/Pacific Islander Men	5.30	4.79	4.69	4.66	5.05	5.49	6.03	6.75	6.81	6.90
Hispanic Men	2.90	2.69	2.78	2.52	2.52	2.58	2.64	2.81	2.93	3.18
American Indian/Alaska Native Men	0.32	0.27	0.22	0.24	0.28	0.23	0.27	0.27	0.27	0.26
Unknown Men	1.47	1.68	1.72	1.77	1.83	1.87	2.07	2.22	2.26	2.56
White Women	40.03	40.97	41.30	41.02	40.10	39.47	38.06	36.72	36.24	35.18
African American Women	5.56	5.57	5.79	5.90	5.69	5.61	5.59	5.47	5.45	5.17
Asian American/Pacific Islander Women	7.07	7.18	7.24	7.69	8.34	8.75	9.00	9.32	9.52	9.56
Hispanic Women	4.61	4.56	5.03	4.79	4.78	4.59	4.44	4.68	4.75	5.00
American Indian/Alaska Native Women	0.39	0.41	0.39	0.42	0.47	0.45	0.42	0.37	0.43	0.37
Unknown Women	2.08	2.28	2.47	2.66	2.78	2.84	2.91	3.19	3.27	3.68
Computer Sciences										
White Men	47.64	47.29	46.20	46.33	48.79	50.88	53.32	53.76	54.09	52.85
African American Men	5.85	5.88	6.10	6.34	6.78	7.06	7.38	7.20	6.92	7.25
Asian American/Pacific Islander Men	10.77	10.70	10.69	9.74	9.30	7.95	7.08	6.83	6.33	6.23
Hispanic Men	4.12	4.21	4.64	4.91	5.14	5.70	5.83	6.39	6.57	6.63
American Indian/Alaska Native Men	0.49	0.32	0.37	0.62	0.39	0.43	0.46	0.45	0.42	0.48
Unknown Men	3.80	4.40	5.38	7.33	7.50	7.48	7.49	7.93	7.97	8.51
White Women	13.69	13.18	12.29	10.86	9.99	9.14	9.01	8.72	8.67	9.13
African American Women	5.04	5.16	5.36	5.06	4.71	4.69	4.04	3.60	3.63	3.39
Asian American/Pacific Islander Women	5.14	5.18	4.89	4.22	3.25	2.46	1.84	1.61	1.56	1.66
Hispanic Women	1.84	1.85	2.13	1.93	1.84	1.76	1.57	1.48	1.61	1.54
American Indian/Alaska Native Women	0.20	0.19	0.16	0.19	0.17	0.18	0.16	0.15	0.16	0.16
Unknown Women	1.42	1.63	1.80	2.47	2.14	2.28	1.83	1.88	2.07	2.17

Table 1.1 (Continued)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Physical Sciences										
White Men	44.02	43.69	44.63	44.08	43.56	43.30	43.31	42.46	42.30	41.83
African American Men	3.06	3.03	2.77	2.69	2.64	2.65	2.73	2.67	2.78	2.61
Asian American/Pacific Islander Men	5.06	4.62	4.34	4.61	4.35	5.00	5.53	6.14	6.08	6.30
Hispanic Men	3.36	3.17	3.30	3.19	3.16	3.05	3.46	3.40	3.38	3.40
American Indian/Alaska Native Men	0.29	0.32	0.34	0.34	0.43	0.36	0.36	0.33	0.49	0.37
Unknown Men	2.47	2.47	2.97	2.90	3.14	3.31	3.59	3.71	3.46	4.35
White Women	28.09	28.31	28.42	27.95	28.13	27.19	26.28	25.94	25.99	25.96
African American Women	4.27	4.54	4.06	4.34	4.09	4.01	3.68	3.76	3.83	3.57
Asian American/Pacific Islander Women	4.83	4.42	4.08	4.41	4.83	5.36	5.55	5.51	5.85	5.73
Hispanic Women	3.05	3.25	3.03	3.30	3.38	3.28	2.88	3.25	3.44	3.20
American Indian/Alaska Native Women	0.24	0.30	0.35	0.21	0.29	0.29	0.36	0.31	0.29	0.24
Unknown Women	1.27	1.89	1.70	1.97	2.00	2.21	2.26	2.54	2.10	2.45
Engineering										
White Men	57.80	57.27	57.42	57.00	56.76	56.77	57.76	57.72	57.60	57.41
African American Men	3.40	3.36	3.41	3.54	3.46	3.50	3.44	3.35	3.36	3.26
Asian American/Pacific Islander Men	9.75	9.35	9.34	9.33	10.03	10.17	10.24	9.87	9.74	9.28
Hispanic Men	5.57	5.47	5.54	5.61	5.65	5.92	5.91	6.10	6.49	6.58
American Indian/Alaska Native Men	0.35	0.42	0.41	0.40	0.44	0.44	0.37	0.44	0.41	0.41
Unknown Men	2.81	2.97	3.37	3.58	3.73	3.82	3.85	4.09	4.48	4.79
White Women	12.87	13.19	12.85	12.58	11.94	11.76	11.09	11.32	11.01	11.23
African American Women	1.88	1.94	1.79	1.83	1.77	1.55	1.51	1.36	1.29	1.15
Asian American/Pacific Islander Women	3.07	3.29	3.12	3.36	3.34	3.29	3.01	2.83	2.68	2.74
Hispanic Women	1.76	1.87	1.78	1.85	1.88	1.84	1.86	1.87	1.90	1.93
American Indian/Alaska Native Women	0.12	0.13	0.12	0.15	0.13	0.11	0.10	0.08	0.11	0.11
Unknown Women	0.63	0.76	0.85	0.78	0.87	0.82	0.86	0.96	0.93	1.10
Mathematics										
White Men	38.51	39.65	39.60	40.15	39.69	39.88	40.55	40.25	40.20	39.90
African American Men	3.24	3.16	3.06	2.57	2.96	2.90	2.73	2.63	2.86	2.60
Asian American/Pacific Islander Men	4.38	4.37	4.92	5.14	5.64	5.31	5.32	5.70	5.97	6.14
Hispanic Men	3.00	2.88	3.06	2.82	3.37	3.34	3.53	3.34	3.65	3.75
American Indian/Alaska Native Men	0.25	0.25	0.25	0.28	0.34	0.23	0.24	0.32	0.23	0.26
Unknown Men	2.25	2.43	3.03	2.99	3.18	3.15	3.46	3.69	3.90	4.11
White Women	35.59	34.40	33.58	33.57	32.49	32.20	31.76	31.87	30.80	30.71
African American Women	4.10	3.98	3.40	3.42	3.12	2.94	2.88	2.65	2.62	2.67
Asian American/Pacific Islander Women	3.94	4.11	4.50	4.39	4.46	4.67	4.37	4.32	4.22	4.16
Hispanic Women	2.68	2.81	2.43	2.37	2.48	2.73	2.84	2.79	2.71	2.60
American Indian/Alaska Native Women	0.21	0.24	0.29	0.17	0.20	0.21	0.19	0.17	0.23	0.22
Unknown Women	1.85	1.71	1.90	2.12	2.08	2.43	2.14	2.27	2.61	2.88

Source: National Science Foundation, National Center for Science and Engineering Statistics. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*. Special Report NSF 13-304. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/

Typically the dilemma within STEM-related fields has been referred to as a gender crisis. There is considerable merit to this argument due to the large proportion of males that continue to outnumber their female counterparts in various STEM disciplines. The influence of women has grown across the sciences; however, Table 1.2 illustrates the divisive line that most often separates the genders in STEM. According to multiple sources, females have reached parity or outnumber males in both undergraduate and graduate programs within the life sciences (NAS, 2006; NSF, 2013). More specifically, Table 1.2 shows that biological sciences are heavily represented by women, who outnumber their male counterparts by nearly 10% in the number of bachelor's degrees earned in 2010 (National Science Foundation, 2013). Similar trends were found in Table 1.2 for agricultural sciences as well (National Science Foundation, 2013). Nevertheless, the gender disparity still exists within disciplines such as computer sciences, physical sciences, engineering, and mathematics according the statistics displayed in Table 1.2.

Table 1.2: Science and engineering bachelor's degrees awarded in 2010 to US citizens and permanent residents, by gender

Majors	Female	Male
Agricultural Sciences	52.5	47.5
Biological Sciences	59.0	41.0
Computer Sciences	18.2	81.8
Physical Sciences	41.3	58.7
Engineering	18.4	81.6
Mathematics	43.1	56.9

Source: National Science Foundation, National Center for Science and Engineering Statistics. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*. Special Report NSF 13-304. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/

Inequity in STEM has also been described as a racial dilemma. Despite the advances of people of color in STEM over that past 10 years (see Table 1.1), a disparity still exists in the number of bachelor's degrees awarded to racial minorities in STEM

majors. Table 1.3 below describes the overwhelmingly large representation of White students receiving bachelor's degrees in STEM. With the exception of Asian American and Pacific Islander students (who are only underrepresented in agricultural sciences), racial minorities are underrepresented in the number of students receiving bachelor's degrees in STEM in comparison to their population distribution in the United States. A closer look at the data represented in Table 1.3 reveals that African Americans, in particular, are underrepresented in all of the STEM categories displayed.

Table 1.3: Science and engineering bachelor's degrees awarded in 2010 to US citizens and permanent residents, by race/ethnicity

		Major					
Race/Ethnicity	Population Distribution	Agricultural Sciences	Biological Sciences	Computer Sciences	Physical Sciences	Engineering	Mathematics
White	63.7	81.00	61.10	61.98	67.79	68.64	70.61
African American	12.2	2.96	7.39	10.63	6.18	4.41	5.27
Asian American/Pacific Islander	4.9	4.13	16.46	7.89	12.03	12.03	10.30
Hispanic	16.4	4.97	8.18	8.17	6.60	8.51	6.35
American Indian/Alaska Native	0.7	.87	.63	.65	.61	.52	.48
Unknown	2.1	6.07	6.24	10.68	6.79	5.89	6.99

Source: National Science Foundation, National Center for Science and Engineering Statistics. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*. Special Report NSF 13-304. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/.

Among African Americans in STEM, trends in STEM bachelor's degree attainment differ according to gender. African American women outnumber African American men in the number of degrees awarded in agricultural (58.99%) and biological (69.96%) sciences as displayed in Table 1.4 below. An interesting finding in Table 1.3 reveals that the trends in physical sciences (57.72%) show a higher percentage of bachelor's degrees awarded in STEM to African American females compared to African American men and parity across this racial group in degrees awarded in mathematics;

50.60% and 49.40% respectively. However, when considering that African American females comprise 60% of the total number of African American students enrolled full-time in public universities, the percentage of African American women receiving bachelor's degrees in physical sciences and mathematics does not reflect the enrollment rates of this subgroup. This same pattern can be applied to the representation of African American women in agricultural sciences as well. The data indicate that even though African American women attend college in greater proportions than African American men, they are underrepresented in STEM majors with the exception of biological sciences.

Table 1.4: Science and engineering bachelor's degrees awarded to African Americans in 2010, by gender

Majors	Female	Male
Agricultural Sciences	58.99	41.01
Biological Sciences	69.96	30.04
Computer Sciences	31.85	68.15
Physical Sciences	57.72	42.28
Engineering	26.12	73.88
Mathematics	50.60	49.40
Total Enrollment in 4-year Public Universities	60.02	39.98

Source: National Science Foundation, National Center for Science and Engineering Statistics. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*. Special Report NSF 13-304. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/

The statistics represented below are especially acute for African American women in STEM in comparison to White women. According to Table 1.5, White women make up 54.84% of the total number of women enrolled in undergraduate studies, yet they far outnumber racial minority groups in the number of STEM bachelor's degrees received. While African American women are slightly overrepresented in computer sciences (18.76%) in comparison to their population distribution, a disparity still exists in the

overwhelming number of White women who receive bachelor's degrees in STEM in comparison to other subgroups of women, with the exception of Asian Americans and Pacific Islanders.

Table 1.5: Science and engineering bachelor's degrees awarded to females 18-24 in 2010, by race/ethnicity

	Major						
Race/Ethnicity	Undergraduate College Enrollment	Agricultural Sciences	Biological Sciences	Computer Sciences	Physical Sciences	Engineering	Mathematics
White	54.84	79.00	59.66	50.59	63.10	61.49	71.03
African American	15.28	3.33	8.77	18.76	8.67	6.31	6.17
Asian American/Pacific Islander	5.29	4.95	16.21	9.18	13.92	15.02	9.63
Hispanic	14.23	5.43	8.48	8.55	7.77	10.54	6.01
American Indian/Alaska Native	.98	.77	.63	.91	.59	.60	.51
Unknown	9.38	6.48	6.25	12.01	5.95	6.04	6.65
Total	100	100	100	100	100	100	100

Source: National Science Foundation, National Center for Science and Engineering Statistics. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*. Special Report NSF 13-304. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/.

Overall, the findings reveal that while the number of African American women graduating with degrees in STEM has increased since 2001, there remains a considerable underrepresentation of African American women in STEM fields relative to their increased enrollment in colleges and universities. So why is it that African American women are matriculating to college in increasing numbers since 2001 (See Table 1.6), yet they continue to lag behind White men and women in STEM? What is it about being both African American and female that can explain why African American women are underrepresented in STEM? Research indicates that exposure to rigorous curriculum and instruction; opportunities to learn; the structure and culture of STEM; and the intersection of race, gender and SES all influence the likelihood of African American women to successfully major in STEM.

Table 1.6: Undergraduate enrollment at 4-year institutions for African American females

Year	Number of Students Enrolled
2001	535, 862
2002	558,810
2003	591,964
2004	624,302
2005	652,786
2006	663,139
2007	687,237
2008	746,849
2009	824,346
2010	861,642

Source: National Science Foundation, National Center for Science and Engineering Statistics. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*. Special Report NSF 13-304. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/.

Academic preparation is a key factor when examining the persistence of African American women in STEM. Researchers agree that the number of advanced science and math courses a student takes increases their likelihood of performing better on standardized tests (May & Chubin, 2003; Frizell & Nave, 2008; Tyson et al., 2007; Perna et al., 2009). However, students from historically disadvantaged backgrounds are less likely to have access to advanced high school courses in science and math and/or high quality teachers, which negatively influences their ability to enter and successfully complete STEM majors in college (May & Chubin, 2003; Frizell & Nave, 2008; Tyson et al., 2007; Perna et al., 2009). Hanson (2009) found that while African American females are just as likely to take courses in science and math in high school, their standardized test scores continue to fall below those of White females.

Also noted in the literature on STEM achievement is the precollege experiences in STEM that students engage in within and outside of their classrooms. Russell and Atwater (2005) described these opportunities to learn as participation in STEM magnet programs, science fairs, co-curricular science organizations/programs, and rigorous

experiences in math and science classrooms, all of which positively influence the STEM academic experiences of students in college. African American women are not always exposed to these types of experiences. A recent publication also describes the lack of opportunities to learn in STEM for students of color as the lack of role models for females of color in STEM (NAS, 2011). Researchers suggest increasing the number of role models and teachers who can serve as a support system to African American women in STEM as it has been said to produce positive outcomes such as higher GPAs, lower attrition, and increased self-efficacy (Santos & Reigadas, 2002; NAS, 2011).

Opportunities to learn in STEM for African American females are also shaped by the types of universities they attend. Research demonstrates that compared to their counterparts who attend predominantly White colleges and universities, African American students who attend historically Black colleges and universities (HBCUs) experience less social isolation, alienation, personal dissatisfaction, and overt racism (Harper et al., 2004; Pascarella & Terenzini, 2005; Perna et al., 2009) and that HBCUs seem to provide a social, cultural, and racial environment that is more supportive, caring, and nurturing for students and promotes academic achievement and success (Harper et al., 2004). This research supports findings that suggest that HBCUs are instrumental in fostering STEM success for African American women while predominantly White institutions (PWIs) may struggle at times to provide culturally affirming opportunities to learn and major in STEM for African American women (Harper et al., 2004; Pascarella & Terenzini, 2005; Perna et al., 2009).

Opportunities to learn also come from students' families and backgrounds. African American female students from disadvantaged families are at greater risk of

failing to matriculate to college or major in STEM. Understanding race, ethnicity, and culture in family processes is challenging for scholars in the field of STEM education (Few, 2007). Extensive research has documented economic pressures, lack of parental involvement in education, welfare dependence, parent-child conflict, and other problematic issues within the African American family all of which decrease the likelihood that an African American female will go to college and major in STEM (Hall, 2010; Grier-Reed, Maydun, & Buckley, 2008 Henry, West, & Jackson, 2010). While all of the aforementioned factors can be viewed as a lack of opportunities to learn for African American women in STEM, there is a growing body of literature that describes how African American females leverage their familial support in ways that help them succeed academically (Hanson, 2009; Hrabowski et al., 2002).

Historically, the culture of STEM has been heavily influenced by men. The access to rigorous curriculum and opportunities to learn as described above often align with masculine norms and operate in ways that decrease opportunities for women in STEM, particularly African American women (Carlone & Johnson, 2007). "Because science is an enterprise in which facts are created by human beings, socialization and group characteristics are important insofar as they influence the values and beliefs of people who become scientists" (Leggon, 2006, p.325). Collins (2004) asserts that knowledge is shaped by both gender and race; therefore, who practices science considerably influences research in terms of problem choice, data collection and analysis (Leggon, 2006). Who practices science also affects how data is disseminated and the presentation format of the research. "Format refers to whether the data are presented so as to be understandable. Format also refers to how data are presented—and misrepresented— as when, for

example, some data are emphasized while other equally important data are downplayed, obscured, or eliminated" (Leggon, 2006, p. 325). This structure in and of itself has historically diminished the opportunities for African American women in STEM.

Race/ethnicity, gender, and SES affect how knowledge is formulated, interpreted and perceived; these effects are not additive, but synergistic. These identity markers are so inextricably intertwined that it is often difficult for women to distinguish one from the other (Leggon, 2006; Turner, 2002). ''Intersectional paradigms view race, class, gender, sexuality, ethnicity, and age...as mutually constructing systems of power or a specific constellation of social practices that show how oppressions converge'' (Collins, 2004, p. 11). The intersectionality of race, gender, SES, and STEM intertwined in ways that created unique experiences for the African American women in this study. It is their individual stories that respond to some of the most pressing questions concerning the underrepresentation of African American women in STEM majors.

Given the increased enrollment of African American women in college and STEM over the last 10 years (see Table 1.6), it may appear that targeted efforts in STEM retention and completion are not necessary for this particular subgroup. Since the publication of *The Double Bind: The Problem of Being a Minority Woman in Science* (Malcom, 1976), professional associations and organizations have been formed to serve the needs of African American women in STEM (Ong et al., 2011). Despite the publication's intention, the issues pertaining to African American women in STEM have been largely ignored by policy makers and institutions of higher education. "There have been no sustained efforts to serve and support African American women in STEM possibly due to the misguided idea that burgeoning efforts by the NSF and other

institutions aiming to serve women *or* minorities would, consequently, serve African American women" (Ong et al., 2011, p. 176). Unfortunately, programs intended to serve women disproportionately advantage White women, and programs intended to serve minorities generally benefit minority males (Ong et al., 2011). This reasoning warrants additional investigation of the factors that foster STEM completion for African American females so as to provide a better understanding of what organizations, institutions, and various support networks can do to increase the representation of African American women in STEM fields.

Given the patriarchal history and focus of STEM educational research, the continued research of African American women in STEM is most pressing. Gender and racial diversification within STEM is inextricably linked to innovations within the academic and scientific enterprise itself. The unique cultural traditions, backgrounds, experiences, and perspectives of African American women could bring about radically innovative approaches in scientific discovery and could be leveraged to assist in solving some of the most complex technological problems of our time (ACGPA, 2009; Bement, 2009). Equally, their work in STEM would have the potential to advance the quality of life for all American citizens, especially marginalized segments of the population (Ong et al., 2011).

The extant literature is full of findings that reveal the dominance of men, particularly White and Asian males, in STEM careers (NAS, 2006, 2007, 2011; NSB, 2010, 2012; NSF, 2011). Little is written about the experiences of women in STEM, more specifically women of color. In fact, it is difficult to articulate what is missing from the literature on these students. In reality, so little is known about the African American

female experience in this area that programs, policies, procedures, and interventions designed for these women have little direct guidance, other than what may exist for African Americans or women in general. This is evidenced by studies that group all women of color together and offer blanketing policy implications that suggest a one size fits all solution (Carlone & Johnson, 2007; Espinosa, 2011; Ong et al., 2011; Towns, 2010).

The following statement succinctly summarizes the implication for further research surrounding African American women in STEM.

> The benefits of equity and justice, in conjunction with our country's shifting demographics and national imperative to further scientific innovation and competitiveness, point to the growing importance of understanding, recruiting, and supporting African American women in STEM education. Thus far, however, a key challenge for researchers, educators, and policy makers drawn to this effort has been the lack of a coherent knowledge base about this population. While there has been much research conducted since 1970 on women in STEM and minorities in STEM, the unique, collective experiences of African American women in STEM have been largely excluded from the research agenda. Reasons for exclusion include the field's operating assumption that efforts targeting racial/ethnic minorities *or* women are sufficient to address the needs and status of African American. However, this assumption disregards the "double bind," in other words, the way in which race/ethnicity and gender function simultaneously to produce distinct experiences for African

> American women STEM. A dedicated research base about African American women would help assess the root causes of attrition, retention, or advancement for this population; to identify and remedy gaps in the research; and to broadly examine and improve upon programmatic, institutional, and nationwide efforts (Ong et al., 2011, p. 176).

This dissertation's focus addressed several lacunae in the higher education and STEM literatures. The majority of the higher education and STEM literature focusing on African American women utilizes a deficit framework approach by highlighting the shortcomings of African American women and positions them as responsible for their own lack of success. In social science and educational research, African American female experiences, in particular, have been left out, "whited out" (subsumed under White females' experiences), blacked out (generalized within the African American male experience), or simply pathologized. The history of the study of African American women has a cyclical pattern of excluding their experiences or simply suppressing their story within (White) feminist or Afrocentric led studies.

Payne (1994) goes on to explain that the deficit-focus of traditional research on African Americans women can be traced back to the original research question itself and the motives of whoever asked the question in the first place. In sum, traditional social science research normally points to the personal and cultural characteristics of racial minorities, while failing to acknowledge institutional, structural racism as something embedded in or central to U.S. society. Consequently, the research paradigms that educational researchers and reformers have had to depend on regularly target the victim and ignore the role of social structures in disparate educational outcomes.

Despite the barriers African American women have experienced in STEM, the data reveals that there are a number of African American women who are succeeding in STEM fields. In addressing the problems identified above that African American women face it is important to investigate the factors that have influenced the population of African American women who are succeeding in STEM. By switching the focus to concentrate on what African American women are doing well as opposed to continuing to over identify what is already known about their underrepresentation in STEM, this study attempts to portray African American women as more than just victims of their racial and gendered circumstance.

This study examines the experiences of 10 successful undergraduate African American women in STEM. The critical race feminist approach focuses on how African American women experienced STEM education during their undergraduate years of college. It repositions the voice of African American females from the margins and places it at the center of the discussion of African American women and STEM. This allowed me to illuminate factors and characteristics that influence the experience of female African American undergraduate STEM majors. Using a critical feminist or asset approach placed African American women at the center of the analysis as opposed to a byproduct of the investigation (Evans-Winters, 2007).

Purpose of the Study

One area, among many, that remains relatively unexplored in the higher education literature is the nature of the factors that influence undergraduate African American female students' academic success and persistence in STEM. In particular, the role of these factors as they intersect with race and gender remains an important area of study.

While some studies have investigated successful African American women in STEM (Hanson, 2004, 2006, 2007; Hrabowski, et al., 2002; Essien-Wood, 2009), there is still more to learn about the nuances of the factors, their interactions with various institutional organizations, and how this particular population of undergraduates perceived the role of the factors in their successes.

This dissertation research aims to build upon previous studies (Hanson, 2004, 2006, 2007; Hrabowski, et al., 2002; Essien-Wood, 2009) by illuminating the experiences of African American females in STEM from their perspectives. This study's contributions can assist researchers and practitioners alike in understanding factors that influence African American females' success in higher education STEM fields. A review of previous research revealed that the experiences of African American women in STEM are a relatively unexplored area.

The purpose of this study was to examine the experiences of 10 African American women undergraduates attending two North Carolina universities in order to understand how their experiences in college influence their academic success as undergraduate STEM majors. Undergraduate African American females in STEM included those who are majoring in a STEM field as identified by the Integrated Postsecondary Education Data System (Knapp et al., 2009) and are enrolled as a junior or senior at their current college. By exploring the unique college experiences in STEM of successful African American women, the findings expand the literature on the experience of African American women in STEM in general. The findings also highlight two areas that are particularly underresearched: (1) the intersection of familial support with persistence in

STEM among African American women; and (2) the formation of African American women's science identity. Thus, the questions guiding this research are:

1) What role does family play in the experiences of African American women undergraduate STEM majors who attended two universities in the University of North Carolina (UNC) system?
2) What factors impact the formation of science identity for African American women undergraduate STEM majors who attended two universities in the University of North Carolina (UNC) system?

Significance of the Study

Currently, there is a small body of research on African American females in higher education (Essien-Wood, 2009). Even fewer scholars have focused on the unique challenges facing these students in higher education (e.g., poor retention and graduation rates, racism, sexism, Eurocentric pedagogy). This study focused on factors that can promote the academic success and persistence of these students. Still, fewer studies have explored the combined role of academic, familial, and institution experiences of African American females in STEM (Hanson, 2007, Hrabowski et al., 2003). This study attempted to expand the small number of studies that address these underresearched topics.

As noted by (Ong et al., 2011), most educational inquiry on diversity in STEM is quantitative in nature. The dissertation utilizes in-depth interviews with 10 African American women I conducted in the Spring of 2013, months before this group was slated to graduate with their baccalaureate degree in a STEM field (with the exception of one participant who was a junior). A strength of this study is its contribution to the literature

of qualitative investigation of African American women attending public universities in the state of North Carolina. Data used in this study are a part of a larger study of African American women who attended all 16 universities in the University of North Carolina system. However, the subset of interviews utilized for this dissertation was chosen based upon the selection criteria used for this study: (1) African American female; (2) junior or senior STEM major; and (3) a student at one of the UNC system universities selected for this study.

The uniqueness of this study can add to the previous literature about the experiences of African American women in STEM. In addition, this dissertation adds to the literature given the nuances that may be specific to this particular sample of women. By engaging the voices of these women in this study, a richer understanding of African American female persistence in STEM was gained. The findings of this study produced knowledge regarding policies and practices that can lead to the academic success and persistence of African American females in higher education. Colleges and universities may benefit from the findings of this study in a way that allows them to develop and sustain programs and policies that attend to the particular concerns and needs of African American women on their campuses.

Finally, the intent of this research was to inform both current and future African American female STEM students so that they might benefit from the knowledge of the experiences of their predecessors in STEM-related fields. As a result, other African American female students could be enlightened by these stories and have the confidence to pursue a STEM degree of their own.

Organization of the Dissertation

This chapter has provided the statement of the problem, research about African American women in STEM, factors that contribute to the underrepresentation of African American women in STEM, the purpose of the study, research questions guiding the study, and the significance of the study.

Chapter two presents a review of literature related to (a) African American women in higher education; (b) The role of Black and White universities in STEM attainment; (c) African American women in science, technology, engineering and mathematics; and (d) the role of minority families in the successful pursuit of undergraduate STEM majors. Also addressed, is the conceptual framework guiding this study, critical race feminist theory.

Chapter three details the study methodology, beginning with a restatement of the study purpose research questions. It elaborates upon the rationale for the use of a qualitative study and the specific use of phenomenology as the research paradigm. In addition, the chapter describes the data collection and analyses processes.

Chapter four begins with a restatement of the study's purpose and research questions. It presents an overview of the findings. It provides specific examples of participants' experiences as they have pursued an undergraduate STEM major.

Chapter five provides an overview of the study. The major themes and subcategories and discussed and analyzed using critical race feminism. Connections are made to the existing literature and recommendations are provided as well. This chapter ends with areas for future research, limitations of the study, and conclusions.

CHAPTER 2: LITERATURE REVIEW

The purpose of this chapter is to review the extant literature on African Americans in higher education, with a focus on African American women in STEM. This chapter will present literature related to (a) current trends in STEM education and the workforce, (b) African American women in STEM, (c) African American women and the organizational structure of higher education, and (d) the role of minority families in pursuing undergraduate STEM degrees. Also it will address the literature related to the conceptual frameworks guiding this study, including critical race feminism.

African American Women in Higher Education

Because of the scarcity of literature pertaining to the persistence of African American women in STEM and the academe as a whole, this study reviews trends related to the participation of African American women in higher education. This focus not only situates the problem within a higher education context that is applicable to the specific academic and social context of STEM, but also helps to frame the problem within the larger body of literature pertaining to minorities in higher education.

The nation's education system is a microcosm of the larger society. Dating back to the first two hundred years of the United States' existence, it was not common for females to be formally educated. Leading up to and after the Civil War, middle-and upper-class White girls in the urban Northeast were taught to read and write, slightly bridging the gap between males and females (Anderson, 1988; Lerner, 1993;

Ogbu, 1990). The same opportunities given to middle-class White women were not afforded to southern African American men and women or rural immigrant White men and women (Anderson, 1988; Lerner, 1993; Ogbu, 1990). After the Civil War schools for special populations emerged including historically Black colleges and universities (HBCUs).

Presently, African Americans are participating in education across various levels. Nonetheless, an increase in higher education enrollment for this group has been slow, and the status of African Americans in education remains relatively unchanged compared to Whites (Zamani and Brown, 2003). According to Zamani (2003), "Although higher education demonstrates considerable student diversity compared to the past, institutions of higher education have yet to mirror societal pluralism" (p. 8). Examining the statistics can be quite ambiguous. Additionally, a larger number of African American college students attend less prestigious institutions, such as community colleges, for profit universities, and regional states universities which still suggest inequity in our higher education system (Altbach, Lomotey, & Rivers, 2002). Moreover enrollments do not equate to graduation. The rates of graduation among African American college students remain relatively lower than among Whites and Asians (NSF, 2013).

Additionally, the literature on student enrollment in higher education by race or ethnicity consistently exposes higher rates of college participation and completion among African American females than African American males. Research suggests that among African Americans, almost two-thirds of undergraduates are women (The Troublesome Decline, 2001). According to recent data, a feminization of African American education is continuing (NSF, 2013).

Despite increases in the participation of African American students in higher education, members of this group continue to face formal and informal barriers to educational attainment. This is reflected in a postsecondary education system that is stratified by socioeconomic status (Altbach, Lomotey, & Rivers, 2002). These barriers are barrier are particularly salient for African American women, who continue to suffer the effects of gender and racial bias with respect to men of color and White men and White women, respectively (Hayes, 2000a, 2000b). More specifically, the hierarchal structure of academic institutions and rules contribute considerably to the underuse (inability to foster the academic experiences of capable students) of African American women in STEM.

The ambiguous nature of these rules may function in a way that results in differential treatment or generates differential outcomes for males and females (NAS, 2006). In his 1991 study of race and gender differences in degree attainment, Trend found that existing research on minorities and women revealed deficiencies in the response of higher education to minority female matriculation issues, including differential access, under preparation, underrepresentation across major fields of study, and attrition. The findings from this study are supposed in more recent studies that examine inequality for women and minorities (Essien-Wood, 2009; Hanson, 2009; Hrabowski, 2002; Johnson, 2007; Ong et al., 2011).

The Role of Historically Black and White Universities in STEM Attainment

The matriculation of African American women in the sciences has been complicated by changing patterns of participation in higher education, resulting in more African Americans attending predominantly White colleges and universities than any

other period in history (Allen, 1992; Farley, 2002; Holmes, Ebbers, Robinson, & Mugender, 2001) A major conclusion from the National Study of African American College Students (NSBCS) (1981-1985) indicated that African Americans are more likely to matriculate at predominantly White colleges and universities as opposed to historically Black colleges and universities (Allen, 1987). Likewise, Allen (1992) estimated that approximately three-fourths of all African American college students attend PWIs. More recent studies confirm that PWIs continue to enroll the majority of the nation's African American college students (Love, 2008; NCES, 2004). Current research indicates that HBCUs only enroll approximately 16% of African American students enrolled in college (Harmon, 2012).

Some researchers have concluded that specific conditions which support African American women's optimal psychological and intellectual development are more likely to be found at predominantly Black rather than predominantly White institutions of higher learning (Perna et al., 2009). This newfound access to PWIs has been offset by noticeable decline in the persistence or lack of educational attainment of African Americans at predominantly White campuses, as compared with their White and Asian cohorts (NCES, 2004). What is troubling about this development is that these institutions, particularly their STEM programs, are typically not responsive to the unique cultural needs brought about by a more diverse student population (Perna et al., 2009).

Research suggests that institutional type, policy, and practice contribute to the academic success of women and minorities in STEM fields. Specifically, colleges and universities that serve predominantly African American populations and/or women appear to be disproportionately effective in promoting the educational attainment of these

groups overall, and in STEM fields in particular (Kim and Conrad 2006). For example, out of the 20 leading producers of African Americans with bachelor's degrees in STEM, all but three are HBCUs (Borden and Brown 2004). An analysis of Integrated Postsecondary Education Data System (IPEDS) data reveals that, in 2004, HBCUs graduated 22% of all bachelor's degrees to African Americans and 30% of the bachelor's degrees to African Americans in STEM fields (Knapp et al., 2009).

Research studies over the years also suggest that HBCUs are significant producers of African Americans STEM majors. Perna (2001) found that HBCUs were a significant manufacturer of African American faculty in STEM fields. Previous studies also show that, compared to African American students who attend predominantly White colleges and universities, African American students who attend HBCUs experience less social isolation, alienation, personal dissatisfaction, and overt racism (Harper et al. 2004; Pascarella and Terenzini 2005) and HBCUs seem to provide a social, cultural, and racial environment that is more supportive, caring, and nurturing for students and promotes academic achievement and success (Harper et al. 2004). Lent et al. (2005) found that African American undergraduates enrolled in introductory engineering classes at two HBCUs displayed higher self-efficacy than their counterparts attending one predominantly White university. The African American students at the two HBCUs also had greater interest in engineering related activities and greater interest in pursuing an engineering major field. Using qualitative data, Perna et al. (2009) found that HBCUs positively influence the pursuit of undergraduate STEM degrees for African American females.

African American Women in STEM

During the past few decades, and particularly, within the last five years, STEM fields and STEM education have been at the forefront of public discourse and the focal point of policy for many educational organizations in the United States (American Association for Advancement in Science, 2006; Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2006; Hill, Corbett, & Rose, 2011; Kuenzi, Matthews, & Mangan, 2006; National Academy of Sciences, 2007, 2011). Improving recruitment and retention in STEM is a critical challenge facing the nation (Ong et al., 2011). The ability of the nation to meet these challenges depends in large measure on science and engineering enterprises (National Academy of Sciences, 2011). It is important to first examine and understand the overall landscape of STEM education and employment in order to describe how African American women fit into the larger context.

Current Trends in STEM

Policy makers and educators point to the need to better prepare our youth to meet the demands of a rapidly evolving economy. Although trends across the nation show that the percentage of students graduating with STEM degrees is increasing, the gains are modest in comparison to the actual number of students who graduate from college. The National Science Board Science and Engineering Indicators 2010 study found that between 2003 and 2007 only 15.6% of bachelor's degrees were awarded in STEM. Meanwhile, several other industrialized nations outpaced the U.S. with China awarding approximately half of its country's university degrees in STEM fields (46.7 %) and South

Korea (37.8 %) and Germany (28.1 %) following closely behind (National Science Board, 2010).

Similar proportions of STEM to non-STEM degrees awarded are reflected across subgroups of the national population. However, women have experienced quite a bit of progress in STEM over the past few years. Females have received about half of the science degrees awarded since that late 1990's, but continue to lag behind in engineering, computer sciences and physics (NSF, 2013). However, more females than males earn degrees in biological, agricultural, and social sciences; psychology; and chemistry (National Science Board, 2012). Similar studies concur with these findings suggesting the need for additional research to further investigate the causes of these phenomena (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2006; NAS, 2006; NCES, 2000a; NSF, 2011).

Across all racial/ethnic groups, universities have shown increases in the total number of bachelor's degrees earned, the number of science and engineering bachelor's degrees earned, and the number of bachelor's degrees earned since 2000 (National Science Board, 2012). However, underrepresented minorities continue to experience low representation in the aforementioned categories. A recent study reports that underrepresented minorities are receiving fewer degrees in STEM not because of a lack of interest; rather the reason is poor degree completion rates (National Science Foundation, 2009). In 2008, Huang, Taddese, and Walter reported that African American, Latino, and Native American students had lower persistence rates (26%) in science and engineering than their White and Asian American counterparts (46%). A more recent study conducted by the Higher Education Research Institute (2010) found that 33% of

White and 42% of Asian American students completed their bachelor's degree in STEM within five years of entering college compared to 18.4% of African American and 22.1% of Latino students. The findings from these studies suggest that underrepresented minorities continue to lag behind their White and Asian counterparts in STEM completion.

The drastic changes in the demographics of the nation's population suggest that the problem of underrepresentation in STEM is all the more urgent because the nation's underrepresented groups are also the fastest growing in the population (National Academy of Sciences, 2011). As a whole, underrepresented minorities make up 28 % of the U.S. population. However, only about nine percent of the science and engineering workforce is made up of underrepresented minorities. The U.S. Census Bureau now projects that underrepresented minorities will represent approximately 45 % of the nation's population by the year 2050 (NAS, 2011). Without a change in action, the margins between underrepresented minority representation in the population and underrepresented minority participation in STEM will continue to increase.

Special attention should be given to African American women because of their dual minority status as women and people of color and the fact that they make up a sizable majority of African Americans in higher education (Ong, 2005). Because they increasingly make up larger percentages of the African American college population, African Americans women's underrepresentation in STEM degree attainment has important implications for African Americans' STEM attainment overall (Ong et al., 2011). Compared to White women, other minority women, and men bachelor's degrees

conferred in STEM for this group are disproportionately low, especially in physical sciences and engineering (Ong et al., 2011).

The Story of African American Females in STEM

Historically, the study of elites has been an integral part of social science theory and research (Hanson, 2009). According to Hanson (2009), "Elites have often been depicted as people who occupy prominent and influential positions in government, corporations, and the military" (p. 1). Researchers have suggested that elites maintain similar interests and attitudes, and have systems that function to promote and foster the participation of some but discourage and exclude others (Domhoff, 1983; Mills, 1956; Zweigenhaft and Domhoff, 1998). In an increasingly technological, global world, the membership status of the elite has changed to reflect the larger society. The status, power, common interests, and dominant networks of those in STEM suggest that they must be considered as members of the new elite. One of the most distinctive traits of the STEM elite (historically and currently) is the lack of women and minorities (Hanson, 2009).

Over the years, the study of women in STEM has increased; however the focus has centered on the differences between males and females with little attention to subgroups of females (Catsambis, 1994; Griffith, 2010; Hanson, 2009; Kimmel, Miller, & Eccles, 2012; Kokkelenberg & Sinha, 2010; Maple & Stage, 1991; Riegle-Crumb & King, 2010). Hence, there is little research on minority women in STEM (Burbridge, 1991; Catsambis, 1995; Hanson, 2009; Perna, Lundy-Wagner, Drezner, Gasman, Yoon, Bose, & Gary, 2009). Even across racial minority status researchers have increasingly come to the conclusion that not all women have the same experiences in STEM (Carlone & Johnson, 2007; Hanson, 2004, 2006, 2007, 2009; Hanson & Palmer-Johnson, 2000;

Johnson, 2006, 2007; Leggon, 2006; Mau, Dominick, & Ellsworth, 1995; Moses, 1989; Ong, Wright, Espinosa, & Orfield, 2011; Towns, 2010).

The extant literature demonstrates that race and gender discrimination continue to persist in the nation's education system—both in general and in STEM (National Science Foundation, 2011). However, "the double jeopardy argument assumes an additive effect of the two statuses—being female and African American" (Hanson, 2007, p. 8). Therefore, a majority of the previous research on African American women has considered the barriers that exist in STEM without considering the intersection of race and gender (Vinning-Brown, 1994). Moreover, the research that has considered the experiences of African American women focuses on the limitations of African American females in STEM as opposed to their success (Farinde & Lewis, 2012)

However, there is an expanding body of research that suggests that regardless of the barriers that science systems create for women of color, it cannot be assumed that members of these groups will be equally indifferent or persist less in STEM (Bonous-Hammarth, 2000; Brown, 2012; Fields, 2005; Hanson, 2007; Huang, Taddese, Walter, & Peng, 2000; Smith & McArdle, 2004; Staniec, 2004). Research has shown that it is common for African American students to hold more positive attitudes about education (Mickelson, 2001, 2013) and STEM than members of any other subgroup and that African American females are especially positive about STEM (Buck, Cook, Quigley, Eastwood, & Luca, 2009), perhaps even more so than their White counterparts. Furthermore, additional research demonstrates that females of all races perform better than (or on par with) males on science grades and achievement in the early years

(Catsambis, 1995). This trend tends to reverse itself for White but not African American youth as these students enter high school (Hanson, 2004).

Studies about African American Women in STEM

A number of studies have examined the success of African American females in STEM, and in large part, they contradict much of the existing literature. Hanson (2004) described young African American women's experiences in science using longitudinal data from the National Educational Longitudinal Survey (NELS) (National Center for Education Statistics, 2002b). The study explored the experiences of students from eighth grade through the postsecondary years and beyond. Measures of science access, attitudes, and achievement were analyzed in this study. Findings from the NELS survey revealed more access to science among young African American females compared to young White females. This greater access persisted through the post–high school years. Hanson found a sizeable White advantage in the area of science achievement. However, when occupational achievement, as measured by obtaining a science occupation, is examined, the White advantage tends to fade. Although the findings demonstrated that beginning in eighth grade, White females were more likely to receive higher grades in science and score higher on standardized science tests; African American females were more likely to report a current or most recent job that was obtained in science eight years out of high school.

Hanson's (2004) study also revealed a distinctly positive attitude toward science for African American females early in their high school careers. When asked in the eighth grade whether they were more likely than young White females to look forward to science class and feel that science would be useful in the future, African American

females responded more positively. By the time African American females reached their last year of high school, patterns shifted to reveal that young White women who showed more interest in science. Later, the trends reversed again when the women were eight years removed from high school. Almost one third of the young African American women reported that the occupation they planned to have at age 30 would be in science. Less than a one fourth of young White women reported these plans. Hanson concluded that African American females show interest in and have access to science early in their high school years relative to White women. This interest is maintained over the years as African American females continue to be represented in science in their adult years relative to the White women in this study.

Scriven (2006) conducted a historical examination of African American women in the sciences from the 1950s to the late 1990s. In particular, she examined the education of African American women in HBCUs with a focus on Spelman College. Despite accounting for less than a percent of U.S. higher education institutions, Scriven (2006) noted that HBCUs produced nearly 30% of African American graduates. When examined by degree field, HBCUs account for the production of even higher percentages of African American scientists, (e.g., 50% of agricultural sciences, 45% of the physical and mathematical sciences; and 42% of the biological sciences). Despite these successes, Scriven noted that HBCUs have faced many structural level barriers (e.g., resources, funding, and political favor) that have hindered their production of African American female scientists (Scriven, 2006).

Until the mid-1950s, the vast majority of HBCUs prepared African American female scientists for professional careers. These roles included the pursuit of careers in

teaching, nursing, and in social service. Scriven (2006) noted that "the thought of African American women as scientists, mathematicians, and engineers was outside the frame of reference—and acceptance—of what society thought African American women could or should be" (p. 279). In stark contrast to these perceptions, Spelman College engaged in a 25-year campaign (beginning in the 1970s) to enhance their science culture and facilitate the success of African American women in the sciences. Fiscal stability through endowments and other forms of fiscal support allowed Spelman College and other HBCUs to facilitate the success of this campaign. As a result of the civil rights and feminist movements of the 1960s and 1970s, popular images about women in science gradually began to shift. Government policy shifted with the times, allowing African American colleges to expand their science programs in order to support the nation's efforts in competing in a global marketplace.

Justin-Johnson (2004) conducted a qualitative study on African American female graduate students in the sciences at PWIs. Her study sought to uncover the experiences of eight recent graduate students in biological sciences and chemistry. Findings from her study illustrated that the collegiate environment experienced by these women is both unwelcoming and unsupportive. Participants noted that this environment negatively affected their persistence towards graduation. Students identified barriers and supports that affected their success in their programs. Barriers to a supportive environment included “(a) having perceptions that the collegiate environment would be unsupportive, unwelcoming, and negative come true; (b) experiencing limited relationships with faculty members, particularly when support was needed to succeed in advanced coursework; (c) encountering a lack of engagement in study groups due to conflicting schedules and

responsibilities; (d) being excluded from study groups or having feelings of isolation within study groups due to a lack of other African American female students; (e) not being invited to participate in social engagements that other students participated in; and (f) having difficulty creating bonds with faculty members and other students" (Justin-Johnson, 2004, p. 140). Students identified several factors that supported their success: "(a) personal factors such as determination, motivation, and other psychological coping mechanism; (b) institutional factors such as engaging faculty, study groups, and supportive bonds with peers; and (c) external influences such as family members and friends" (Justin-Johnson, 2004, p. 140).

Perna et al.'s (2009) study of Spelman College examined the results of five focus groups in which participants were asked questions on peer support, faculty encouragement, student support services, and undergraduate research opportunities. Two of the groups consisted of faculty and administrators while the other three groups consisted of African American undergraduate female students in the sciences. Several themes emerged from the study: (a) all students chose to attend Spelman College because of the school's reputation in promoting the success of African American women in STEM-related fields; (b) all students began their studies with high aspirations and maintained these high aspirations in the STEM field; and (c) students and faculty expressed an awareness of the academic, psychological, and financial barriers that limit African American females in the science field (Perna et al., 2009)

A similar study conducted by Essien-Wood (2010), explored the factors that affect the academic success and persistence of African American females in the natural and physical sciences. Data was collected via in-depth, semi-structured interviews with

15 African American female science majors. Two theoretical frameworks were employed in this study, resiliency theory (Ceja, 2004), a framework that emphasizes the strengths of individuals over their perceived shortcomings, and the concept of micro-aggressions (racial/ethnic and gender), non-physical aggressive interactions between people of different races, cultures, or genders (Sue, Capodilupo, Torino, Bucceri, Holder, Nadal, & Esquilin, 2007). Semi-structured interviews were conducted with 15 undergraduate African American females in the sciences over the course of nine months. Interviewees included eight natural science majors and seven physical science majors.

Given the limited literature on this topic, Essien-Wood's (2009) exploratory study was informed by the research tradition of grounded theory. Findings from this study identified several supportive mechanisms for academic success: family, religion, teaching assistants and friends. Also identified were seven barriers to academic success: employment, lack of diversity, cultural dissonance, unwelcoming college environment, faculty, advisors, classmates, and lab groups. Further, an analysis of students' responses revealed numerous instances of racial and gender microaggressions that thwarted students' academic progress (Essien-Wood, 2009). This study is one of the first to examine the experiences of African American females in STEM through the lens of racial/ethnic or gender micro-aggressions.

This dissertation studies investigates similar phenomena to the aforementioned studies above, yet it samples women from STEM such as engineering and concentrates on the influence of family and science identity on STEM experiences. None of the studies described above specifically investigated the influence of family and the formation of

science identity on STEM experiences separately, much less in conjunction with each other.

The Role of Minority Families in the Successful Pursuit of Undergraduate STEM Majors

Over the years researchers have considered the influence that family factors have on the academic achievement of students. In general, the findings suggest that family support is positively correlated with academic achievement (Buchman & DiPrete, 2006; Fordham, 1996; Hanson, 2009; Hanson & Palmer-Johnson, 2000; Higginbothom & Weber, 1992; Hrabowski et al., 2002). In recent years, the conversation on familial academic influence has expanded to include the distinctive roles families play in the academic achievement of girls and boys.

A study conducted by Buchman and DiPrete (2006), examines the causes of the growing female advantage in college completion using family resources and academic achievement as predictors. Longitudinal data from NELS birth cohorts dating back to 1938 reveal that the shift in college completion rates for males and females is in part due to changes within the family structure. For example, for males born in 1965 or earlier, college completion was more likely regardless of family type. Women were as likely as men to have completed college only when both parents had some level of college completion. Over time the trends in college completion rates for males and females began to reverse. Males became less likely to complete college in part due to absentee or high school-only educated fathers (this finding was more significant and negative for African American males). The comparative advantage in college completion rates for females has continued to increase over the years which this study contributes in some measure to family background. However, the question remains as to which family factors, in

particular, contribute to the successful academic achievement of women in comparison to men (Buchman & DiPrete, 2006).

Familial influence not only has different academic outcomes for girls and boys, but it impacts achievement in dissimilar ways for females across race and ethnicity. In a study that incorporated race and gender in the examination of upward social mobility, researchers found that education was stressed as important in both African American and White families; however, the families differed in how education was viewed and how much it was desired (Higginbothom & Weber, 1992). African American women received the message that marriage was secondary to academic and occupational success. Many African American women also expressed a more communal understanding of their social mobility, as connected to an entire racial uplift process, as opposed to merely an individual journey. The data from this study suggest a mobility process that is stimulated by aspirations for both personal and collective gain and that is molded by interpersonal dedication to family and race.

Trends of successful academic completion are more pronounced among females in the African American community. African American women are performing better academically and completing college at higher rates than African American males in record numbers (Zamani, 2003). Several studies have attempted to isolate characteristics that impact the high achievement of African American girls and have often cited the African American family as a source of agency (Anderson, 1997; Fordham, 1996; Hanson, 2009; Hanson & Palmer-Johnson, 2000; Hill & Sprague, 1999; Higginbothom & Weber, 1992; Hrabowski et al., 2002). Fordham (1996) found that parents of high achieving African American females tend to limit their daughters' friendships and

encourage their involvement in religion, while parents of underachieving girls tend to allow, even encourage, many friends and are generally indifferent about religion. This study also revealed that families of high-achieving African American females tend to prepare their daughters in such a way that while girls are aware of the larger society's perception of them, they are able to deemphasize the possible limitation that might be imposed on them and to focus more heavily on developing strong academic skills.

As described by the literature (Hanson, 2009; Hrabowski, 2002), family is an integral part of student academic achievement in the lives of African American females. Equally important is the role families play in the pursuit of STEM degrees, although this concept is relatively absent in the literature. Quantitative studies have used measures of familial influence such as income and parental education in past STEM studies, but few have engaged in descriptive analysis which examines the lived experiences of these families and their students. Hrabowski et al. (2002) explore factors that assist African American females in becoming successful in science and math. Among the factors examined, researchers found that families played a key role in maintaining the interests of their students in math and science. Through the use of school and summer STEM programs, help with homework, the purchase of science kits, and advocating for proper math and science course placement, these families were able contribute in meaningful ways to their students' persistence in STEM (Hrabowski et al, 2002).

After an exhaustive review of the literature, I only managed to secure one study that strictly examines the influence of the African American family on African American females' academic achievement in STEM. Hanson (2007) using NELS data from previous studies (Hanson, 2004, 2006), examines the role of minority families in the

success of African American women in science. Measures of family factors and science experiences were used to produce both quantitative and qualitative findings. Multivariate logistic regression models determined that family encouragement in science positively and significantly impacted science outcomes for African American females. Additionally, African American girls performed better in science. Despite the fact that African American females feel less integrated in science than young White females, their curiosity and participation in science persists because of the family; both mother and father's influence is important. Family variables positively influence the success of African American females in science in the quantitative findings; however not all of the young women acknowledged or verbalized their awareness of this influence in the qualitative findings. Instead, the young women often view their actions as independent. Hanson's study contributes to the limited body of research that acknowledges family and academic achievement in STEM for African American females as mutually exclusive factors of educational attainment.

This study attempts to extend the work of Hanson (2007) and others. By investigating similar qualitative inquiries, I sought to understand the experiences of African American women in STEM and the role of family in these experiences. A significant number of the women in Hanson's study reported that their families influenced their experiences in science. This study attempted to reveal findings that either support, extend, or refute Hanson's (2007) qualitative research by conducting semi-structured interviews. Due to the small sample size of African American women with college degrees in STEM, Hanson's study mainly focuses on high school measures and family factors that influence success in STEM for African American women. This study

attempts to extend Hanson's work by integrating the college experiences and familial factors that influence STEM degree attainment. This approach provides a more extensive understanding of how familial factors, science identity formation, and other education experiences influence the STEM success of African American women over the course of their educational careers.

Black Identity and Science Identity

A discussion of identity is necessary to understand how the women in this study respond to their experiences in STEM. Identity formation also assists in the analysis, along with Critical Race Feminism, of the participants' experiences (Carlone & Johnson, 2007). Cross's (1995) model of Black identity hypothesizes that identity evolves through a series of stages. The five stages are as follows: pre-encounter, encounter, immersion, internalization, and internalization commitment. The stages are defined below.

> Blacks begin their development at a stage called pre-encounter. This stage is characterized by dependency on White (not Black) society for definition and approval; attitudes are anti-Black and Eurocentric in nature. The encounter stage is entered when one has personally challenging experiences with White society. This stage is marked by feelings of confusion and an increasing desire to become more aligned with one's Black identity. The immersion-emersion stage follows the encounter stage and is characterized by a period of pro-Black or Afrocentric, anti-White feelings. One is absorbed in the Black experience and completely rejects the White world. Immersion-emersion is followed by the internalization stage, during which one has grasped the fact that both Blacks and Whites

> have strengths and weaknesses. In addition, one's Black identity is experienced as a positive, important, and valued aspect of self. One's attitude toward Whites is one of tolerance and respect for differences. Along with this level of internalization comes an achievement of pride and security in the Black race and identity. The internalization-commitment stage follows internalization. The primary distinction between the two stages is that internalization-commitment reflects a behavioral style characterized by social activism, and internalization reflects one's level of cognitive development (Coard, Breland, & Raskin, 2001, p. 2258).

This identity model is useful in reflecting upon the experiences of African American women in STEM. Its principles combined with Carlone and Johnson's (2007) science identity will be helpful in refracting the experiences of the participants in this study through a critical race feminist lens.

Carlone and Johnson (2007) constructed a science identity model based on an assumption that gender, race, and ethnic identities affect science identity. The study found that women of color participate in STEM in similar ways and often get recognized (or not) in similar ways. Drawing from previous models (Elmesky & Selier, 2007; Roth, 2006), Carlone and Johnson (2007) approach science identity as "fragile (contingent, situationally emergent) and, if habitually accessed, performed, and recognized as stable, carried across time and context" (p.1192). Their initial science identity model captures three overlapping aspects of science identity: competence, performance, and recognition. Competence is defined as knowledge and understanding of science content; performance is defined as social performances of relevant scientific practices; and recognition is

defined as recognizing oneself and getting recognized by others as a science person. Someone with a stronger science identity would rate themselves highly and be rated highly by other in each of these dimensions, but one can envision various degrees and different configurations of science identity (Carlone & Johnson, 2007).

Theoretical Framework

Silverman (2009) posits that theory provides a footing for considering the world and critically understanding phenomena. There are several frameworks that could potentially explore the experiences of African American women in STEM; however, I selected critical race feminism (CRF) because it focuses specifically on gaining equal rights and opportunities for women of color. Critical Race Feminism is not the only framework that could be utilized in this study, but I chose it as my personal preference.

CRF is a branch of critical race theory that examines the experiences of women of color. It places the knowledge and experiences of minority women in at the center of the discourse. The focus is primarily on the multiple identities of women of color and how their experiences are a product of those identities (Pratt-Clarke, 2010). CRF was first used in legal studies, and later in social and behavioral science research. Therefore, CRF, can potentially center the analysis of young, female students' of color experiences within an educational context, similar to its function within law and the social sciences.

Specifically, the research of Evans-Winters and Esposito (2010) in the field of education demonstrates how CRF impacts an understanding of the experiences of African American women. Researchers argue that minority women's perspectives and experiences differ from those of minority males and White women, therefore suggesting that "there is a need for a coalition of educational researchers who seek to understand

African American female's multiple realities" (Evans-Winters & Esposito 2010, p. 15) and how they intersect with their educational experiences. Critical race feminism explores the varied and numerous forms of discrimination females of color experience at the intersection of race, class, and gender within hegemonic systems (Crenshaw et al., 1996). Similarly, critical race feminism supports "anti-essentialist standards of identity, by maintaining a multidisciplinary scope; and, requiring practices that simultaneously analyze and combat gender and racial oppression" (Carter, 2012, p. 3). To truly understand the tenets of critical race feminism and how they apply to educational research, first it is important to explore the foundations of CRF by examining other theoretical frameworks which contributed to the framework's development.

Critical Race Theory

CRF theory is closely related to critical race theory which focuses on eradicating racial oppression as part of a broader goal of ending all forms of oppression (Dixson & Rousseau, 2006). The latter has a social critique focus and commitment to transformation and emancipation (Guba & Lincoln, 1994; Creamer, 2003). The framework encourages the building of social movements and connecting scholar and community is encouraged by this particular framework (Onwuachi-Willig, 2009). It places an emphasis on discourse, stories, words, language, and narrative. I understand CRT as a framework that started with legal analysis, but its lens applies to all domains of inquiry. CRT informs education theory, research, pedagogy, curriculum, and policy. (Ladson-Billings & Tate, 1995; Dixson & Rousseau, 2006; Yosso, 2006).

CRT first examined racism in the American legal system and the "legal manifestation of White supremacy and the perpetuation of the subordination of people of

color" (Wing, 2003, p. 5), including the social construction of race and racism in the legal system. It recognized the permanence and pervasiveness of racism in American society. This framework challenged dominant claims of ahistoricism, objectivity, neutrality, colorblindness and merit in the law. It affirmed and acknowledged the experiential knowledge of people of color through a contextual and historical analysis of the law and its operation within society (Bell, 1992).

Feminist Legal Theory

During the emergence of critical legal theory and critical race theory in the 1970s and 1980s, another movement was budding. Feminist legal theory (FLT), an outlet of critical legal studies, began to question the essentialist nature of critical legal theory by suggesting that not adhering to the issues faced by women perpetuates discrimination as opposed to eliminating it. FLT centers the focus on gender by employing a framework that corresponds with the experiences of women while simultaneously promoting equality among men and women (Rhodes, 1990). Like other critical movements, feminist legal theory attempts to deconstruct liberal legalism and colorblindness. However, FLT extends these theoretical tenets from a gendered perspective. It is important to note that FLT is not a legal paradigm; rather it is an epistemological framework that has been applied to legal analyses and later to social science and educational studies (Fineman, 2005).

Two diverging camps have evolved since the construction of FLT. The first group of feminist legal theorists concentrates on decreasing the focus on difference, and instead focuses on the sameness that exists between men and women. The second groups' attempts to build upon the difference that exists between women and men to transform

policies and laws (Fineman, 2005). While the tenets projected by feminist legal scholars are semi-progressive, the ideas of sameness and differences are based on the experiences of White women.

Black Feminism

CRF is an interdisciplinary framework having blended roots in several fields of study including those discussed above in addition to critical legal studies, gender studies, race and ethnic studies, and communication studies (Pratt-Clarke, 2010). The challenge, however, of interdisciplinarity is reflected by Wing's (2003) acknowledgement that the use of other academic disciplines is "still embryonic in nature as most legal scholars only hold law degrees and may be self taught in other fields" (p. 6). Critical race feminism does, however, draw heavily from African American feminism, which has a foundation in sociology and literary studies.

African American feminist scholarship examines the multiple oppressions that African American women experience as a result of their race, gender, and class statuses and the consequences of those oppressions, including exclusion and the silencing of their voices (Barnett, 1993; Collins, 2000; Guy-Sheftall, 1995; hooks, 1981, 1990; King, 1992; Marable, 1983). African American feminism emphasizes that multiple, varied, and dynamic oppressions faced by African American women must be viewed as intersecting, rather than as simply additive and hierarchal (Brewer, 1989, 1993; Collins, 2000; Deitch, 1993; Ferguson, 1990; Gregory, 1993; Griffin & Korstad, 1995; Hamer & Neville, 2001; hooks, 1981, 1984; Howard-Hamilton, 2003; Hull, Scott, & Smith, 1982; King, 1988, 1992; Sacks, 1989; Williams, 1984). African American feminism incorporates concepts of intersecting identities, interlocking social structures and systems, and personal

experiences and stories into its analytical framework. The strength of an African American feminist framework lies in its ability to facilitate an analysis of the experiences of African American women as reflected by the text, language, discourse, and words used in particular events or contexts. It also recognizes the importance of examining the local and historical context in which experiences unfold (Ken, 2008).

Critical Race Feminism in Education

According to Evans-Winters and Esposito (2010), CRF in education benefits research and theory building about the educational experience of African American women in the following ways:

> Critical race feminism as a theoretical lens and movement posits that women of color's experiences, thus perspectives are different from the experience of men of color and those of White women;
>
> Critical race feminism focuses on the lives of women of color who face multiple forms of discrimination due to their intersections of race, class, and gender within as system of White male patriarchy and racist oppression;
>
> Critical race feminism asserts the multiples identities and consciousness of women of color;
>
> Critical race feminism is multidisciplinary in scope and breadth; and
>
> Critical race feminism calls for theories and practices that simultaneously study and combat gender and racial oppression (p. 20).

After considering the strengths and weaknesses of other theoretical frameworks, I conclude it is important that I advocate for the use of critical race feminism in this study. There are many similarities and differences between African American feminism and critical race feminism, the most closely related among the theoretical frameworks. For example, both theories acknowledge the fundamental value of racial/ethnic scholarship in

representing the experiences of groups of which researchers are members. Both theories emphasize the notion that differences can work to strategically empower or marginalize individuals and groups (Few, 2007).

The sharpest difference between the two frameworks is one of disciplinary birthplace. CRF emerged from CRT and as an epistemological framework first applied to legal studies. African American feminism materialized as a product of grassroots activism and social science and humanities scholarship (Wing, 2000). Most important to the context of this study is the difference between African American feminist analysis and critical race feminist analysis. African American feminist exclusively describe the experiences of African American women and women of the African diaspora. Critical race feminists examine the social, political and economic issues for all racial/ethnic groups by contextualizing the sociocultural experiences of these groups (Few, 2007). By utilizing a theoretical framework that is applicable to other minority women, the findings from this study could potentially suggest areas for research that could be investigate using similar methods and samples.

Evans-Winters and Esposito (2010) suggest that African American females' experience education differently from males of color and young White women. "Therefore, using a critical race feminist lens in the examination of the educational experiences of African American female students allows for the avoidance of gender and racial essentialism" (Evans-Winters & Esposito, 2010, p. 21). Carter (2012) suggests that utilizing CRF as opposed to Black feminism allows for the critical examination of the structural and hegemonic inequalities that contribute to educational inequities because it is multidisciplinary. I am using CRF as opposed to African American feminism because

of the aforementioned reasons above; however either could effectively provide a framework to analyze the experience of the African American women in this study.

One goal of CRF is to synthesize and utilize the bodies of knowledge in a theoretical analysis to create comprehensive and practical strategies which address the educational needs of students (Wing & Willis, 1999). African American women need theoretical frameworks in education that recognize and celebrate the vulnerability and spirit of minority women (Evans-Winters & Esposito, 2010). According to Evans-Winters & Esposito (2010), "Critical race feminism in education offers a more nuanced and straightforward framework for contending with the social, economic, political and educational problems confronting African American female students inside and outside of schools" (p. 23). The extension of CRF to social problems allows this study to analyze the intersection of science identity formation and familial experiences for African American women in STEM.

Summary

This chapter has demonstrated that education of African American women in STEM is influenced by a myriad of factors. It began with a historical overview of African American women in higher education which revealed the need for more studies that focus on the experiences of this particular group of women. The overall state of STEM education and employment was explored next follow by current trends for African American women in STEM. African American identity and science identity were also explored in regards to current trends for African American women in STEM. An examination of extant literature on the influence of minority families on African American female's persistence in STEM revealed two studies that were published as

books and in academic journals. After a discussion of these studies and how they influence the need for this study, I reviewed the theoretical framework (critical race feminism) its relationship to the study. The next chapter explores the research design of the study I conducted to investigate the issues raised in this review of the extant literature on African American women in STEM.

CHAPTER 3: METHODOLOGY

This study explored the persistence and success of African American female STEM undergraduate students. In particular, this study examined the intersection of race and gender in STEM higher education in relation to the familial support and academic experiences and institutions that influence degree completion in African American female STEM students.

This chapter includes a review of the research purpose and research questions, a brief summary of qualitative research and its use in this study, an overview of phenomenology and the rationale for the use of this particular research method, and a description of the research design and procedures. The research procedures portion of this chapter includes an explanation of participant recruitment, data collection, data analysis, strategies to ensure the quality of the study, and limitation of the study. The following research question guided this study:

1) What role does family play in the experiences of African American women undergraduate STEM majors who attended two universities in the UNC system?
2) What factors impact the formation of science identity for African American women undergraduate STEM majors who attended two universities in the UNC system?

Qualitative research is best suited for this study due to the nature of the research questions and the need to provide a more detailed analysis of the participants' lived experiences. Additionally, there has not been a considerable amount of qualitative research conducted on this particular topic. The majority of the existing research is quantitative.

Qualitative Research

Denzin and Lincoln (1994) consider qualitative research to be "multimethod in focus, involving an interpretive, naturalistic approach to its subject matter" (p. 2). Creswell (2003) defines qualitative research as an "inquiry process of understanding based on [the exploration] of a social or human problem" (p. 15). A qualitative research approach allows researchers to understand and describe social phenomena within the natural setting using rich and thick descriptions (Merriam, 2002). This research method is most appropriate when seeking to describe the *how* or *what* of the topic being explored (Creswell, 1998). It allows individuals to interact with their social worlds and make sense of their worlds based on their own experiences (Patton, 2002). This study operated within a constructivist epistemological framework which allowed me to explore the socially constructed realities of the participants. A qualitative, constructivist view provided a framework for me to describe meanings, understand participants' definitions of the situation, and examine how objective realities are produced. Critical race feminism was the theoretical framework that informed the constructivist research paradigm. Within this framework, I utilized a phenomenological research method which sought to describe rather than explain participants' experiences.

Phenomenology

Phenomenology is an inductive method that attempts to explain the meaning structures developed through the experiences of the participant being studied (Holroyd, 2001). The history of phenomenology dates back to the writings of German philosopher and mathematician Edmund Husserl (Creswell, 1998, Moustakas, 1994). Husserl's tenets are premised on the "search for the essential, invariant structure or the central underlying meaning of the experience" (Creswell, 1998). He emphasizes the intentionality of consciousness where the experiences are revealed through memory, image and meaning. Moustakas (1994) states that Husserl's phenomenology is a transcendental phenomenology. It emphasizes subjectivity and the bracketing of thoughts so that what appears in the consciousness of those being studied is an absolute reality, not the learned experiences of the researcher.

Phenomenology can be used as a theoretical framework or a research method. As a research method, phenomenology focuses on exploring how human beings make sense of experiences and transform experience into consciousness and then into action, both individually and as shared meaning (Patton, 1990). It is this examination of lived experiences and extensive prolonged engagement to develop patterns and relationships of meaning which differentiate phenomenology from other interpretive approaches (i.e. ethnography and grounded theory) (Creswell, 2007). As described in the aforementioned sections of this chapter, the amount of research examining the experiences of African American women in STEM using qualitative methods exists but is scarce. I did not come across any studies pertaining to the specific nature of my topic that have utilized phenomenology as the methodological framework. However, I did find a dissertation

study that utilized phenomenology as its framework and has the same racial demographic for the participants studied (Justin-Johnson, 2004).

Justin-Johnson (2004) conducted a qualitative study on African American female graduate students in the sciences at predominantly White institutions (PWI). Using a semi-structured interview protocol she explored the experiences of eight recent graduate students in biological sciences and chemistry. Themes emerged in relation to non-supportive and supportive mechanisms that contributed to the participants' experiences in STEM. Findings from her study illustrated that the collegiate environment experienced by these women is both unwelcoming and unsupportive. The researcher concluded that the collegiate environment negatively affected their persistence towards graduation. Considering the nature of the research questions in the study just described and the similarity of the participants utilized in the aforementioned study and my own, I sought to employ a similar methodological framework which focuses on the live experiences of the participants.

Phenomenology was selected for this study because it is congruent with uncovering African American women's ways of knowing and knowledge development (Evans-Winters & Esposito, 2010; Wilson & Washington, 2007). The use of storytelling and participatory witnessing promotes a theoretically based understanding of the participants' unique perspectives, and the meanings attached to their experiences—facilitated by detailed descriptions (Evans-Winters & Esposito, 2010). Additionally, this framework allows for the discovery of commonalities in discerned themes or categories that not only link participants' academic and familial experiences, but also reveal how

African American women similarly comprehend and interpret sense-data about the social world (Pratt-Clarke, 2010).

Because I share a similar ethnoracial background and academic experience with the participants who were interviewed in this study, it was important that I utilized bracketing or *epochés* techniques. Moustakas (1994) refers to this process as a way to remove the researcher's subjectivity a bias while keeping the participant's experience intact. Below I discuss how I attempted to bracket my own subjectivity by acknowledging my role as a researcher and the similar experiences I bring to the study.

Research Design

Role of Researcher

One of the benefits of conducting qualitative research is the ability to bring the researcher into the study (Creswell, 1998). However, due to my high level of interest and involvement in the study, it is important for me as the researcher to recognize all assumptions and biases as they may relate to the research questions (Creswell, 2003; Richards & Morse, 2007). Therefore, when I began this phenomenological study, I engaged in a reflective process of making explicit understandings, biases, theories, and beliefs related to the study (Laverty, 2003; van Manen, 2007). Because it was not entirely possible to set aside my personal feelings and thoughts (van Manen, 2007), I needed to "become as aware as possible and account for these interpretive influences" (Laverty, 2003, p. 24). To account for these interpretive influences I engaged in bracketing technique that allowed me to "move back and forth between discursive practice and discourse-in-practice, documenting each in turn and making informative references to the other in the process" (Denzin & Lincoln, 2003, p. 235). Using *epochés* as a strategy I was

able to “bracket my previous understandings, past knowledge, and assumptions about the phenomenon” under investigation (Finlay, 2005, p.12). To facilitate this process I kept a reflexivity file (journal) and communicated regularly with other qualitative researchers. This allowed me to record my observations, thoughts, and questions on how my research procedures and previous knowledge interacted with and influenced research participants and vice versa (Glesne, 2011).

Subjectivity

This dissertation study speaks to many personal interests and builds upon experiences gained through my own accomplishments in STEM. My experiences provide insight into the success of African American women in science, technology, engineering and mathematics. Providing a description of my experiences in STEM is essential to acknowledging my personal relevance to this study. Additionally, extracting my own subjectivity from the study provides a significant contribution to the research on African American women in higher education that is potentially replicable for members of other marginalized groups.

I am an African American female who grew up in a small town in the Piedmont area of North Carolina. My grandparents, parents, and siblings were all products of the same Alamance County school system. Neither of my grandparents received a formal education, but I am surrounded by parents, aunts, uncles, a brother and sister who received postsecondary education degrees. A unique characteristic of my extended and nuclear family is the abundance of women who hold bachelor’s degrees in STEM-related fields. This significantly impacted my own decision to pursue a STEM major and

ultimately influenced my decision to conduct research on the higher education experiences of African American women in STEM.

My fascination with science and math began at an early age. I have fond memories of watching Bill Nye the Science Guy on the local television channel and playing with science kits I received for birthdays. I reveled in the opportunity to take things apart and put them back together. I spent many Christmas mornings constructing games and setting up clinics for my parents and siblings to receive medical care (I really loved role playing a doctor). All of these experiences ignited my passion for science and math, but they were reinforced by the support I received from my family.

My mother often recounted her experiences and the adversity she faced as the first African American female to graduate from Elon University, with a biology degree no less! Listening to the hospital stories my aunties, both nurses, shared and visiting UNC Chapel Hill's campus while my cousin and sister pursued STEM degrees were a normal part of everyday life for me. It never occurred to me that African American women "did not do science" because I was enclosed by a circle of women who did just that.

I excelled in school from an early age. I was placed in academically gifted classes in elementary school and continued to enroll in advanced coursework throughout my high school career. My electives in high school were often additional math or science courses and I participated in co-curricular, STEM-related groups. I decided very early on that I would pursue a career in the medical field so I declared a major in biology when I matriculated to UNC Chapel Hill. After a few introductory biology and chemistry courses I felt a bit disheartened by my poor performance, lack of interaction with faculty, and inability to fully immerse myself into the university's STEM climate. As a result, I

questioned my ability to persist in STEM. Instead of transitioning into a social science, I decided to declare an Exercise and Sports Science major instead because it was less rigorous but was an acceptable major for pursuing a medical degree.

Even though I was able to successfully graduate with a STEM degree, it was not in my intended STEM major. From my perspective several factors negatively influenced my trajectory during my undergraduate years. Despite the extensive number of science and math courses I took in high school, I did not feel adequately prepared when I got to college. I was unfamiliar with the course content and when I consulted my professors I was informed that this was material I should have learned in high school. The institution was so consuming that I often found myself uninformed and unaware of where to seek additional help with the content. Nonetheless, I was able to persist and I feel that this was a result of the support that I received from my family and friends during this process.

For example, I recall having quite a bit of trouble in my Chemistry course during my second semester of college so I called my cousin Tanya. Having received a degree herself in Chemistry from the same university, she was able to tutor me some weekends when she was not busy working as a pharmacist. On several occasions, I called my mother in tears about the complexity of college life and she responded by offering words of encouragement and praying for me over the phone. I even remember my Dad coming up on the weekends to get my laundry so that I could spend more time in the library.

The educational values that were instilled in me by my family were a major factor in the completion of my STEM degree. Specifically, the persistence I witnessed of other family members pursuing STEM degrees taught me to work hard, be resilient, and never give up. My own experiences with STEM majors contributed to my interest in this

dissertation's topic. Although my personal experience shaped the construction of this study, I have placed a greater emphasis on the experiences, perceptions and meanings offered by the study's participants.

Over the years I have spoken to numerous African American females about their STEM experiences in college, and I began to see a pattern. Specifically, I learned that African American females who completed STEM degrees tended to share experiences that identified both supportive mechanisms and barriers to their academic success. Supportive mechanisms included: family, religion, community, and friends while barriers to academic success included: the chilly climate of STEM courses, lack of diversity at the university, disconnected faculty, uncooperative classmates, weak high school preparation and lack of academic support. With this dissertation I investigated the aforementioned familial characteristics that influence success in STEM for African American women. Considering the similar background I share with the participants in this study, I made a concerted effort to bracket my thoughts and subjectivity during the data collection and analysis procedures.

Data Collection

Overview of the NSF Study

This dissertation study is linked to a National Science Foundation supported project titled *Finding the Roots: Interactive Influences of Individual Secondary School, and College Institutional Factors on the Success of Women and Underrepresented Minorities in STEM Majors* awarded to Elizabeth Stearns, Roslyn Arlin Mickelson, Melissa Dancy, and Stephanie Moller in 2010. The grant is divided in to several phases with the first utilizing quantitative inquiry to investigate factors that contribute to STEM

success and failure for women and underrepresented minorities at the 16 campuses of the University of North Carolina. The second phase, of which this study is a part, used qualitative methods to further investigate findings from the quantitative data while also exploring additional questions that could not be answered quantitatively.

Participant Selection for NSF Study

Seniors at the 16 campuses of UNC were contacted initially via email and asked to participate in an online screening survey. Student emails were obtained with the assistance of the Directors of Institutional Research at the UNC system universities. A list of email addresses for all students who have more than 90 credit hours were given to the principal investigators of the grant or the recruitment script was forwarded to them by the university institutional research boards. Students who completed the survey received a $25 gift card if they were one of the first 10 people from their universities to finish the survey. Additionally, their names were entered into a drawing for a $100 gift card.

The screening survey was used as a form of purposeful sampling in that "it provided a clear criterion or rationale for the selection of participants, or places to observe, or events, that relates to the research questions" (Ezzy, 2002, p. 74). Using SAS (Statistical Analysis System) as an analytical tool, the survey respondents were grouped into the following categories: majors, leavers, and avoiders. The rationale used to determine the categorization of the groups of participants can be found in Appendix A. If students agreed to participate in and were chosen for the NSF study interviews, they were monetarily compensated with $25 to complete an hour-long interview with the opportunity to win a $200 Amazon gift card through a drawing (two per campus). An

excel spreadsheet was created with all of the participants who had agreed to participate. They were then classified by race and gender as majors, leavers, or avoiders.

Participant Selection for My Study

From the excel sheet, the NSF study principal investigator assigned me participants who fit the following criteria: (1) African American female; (2) junior or senior STEM major; and (3) a student at a UNC system university. Recruitment emails (Appendix B) were sent out which included an overview of the NSF study, compensation for participation, and request for interview format. Attached to the recruitment email was a letter of consent which included the following information: purpose of the NSF study; list of researchers; inclusion criteria; interview format; compensation for participants; and potential risks and benefits to participants. Once contacted by phone, Skype, or in-person, participants were required to give verbal consent before participating in the interview.

Of the total 20 interviews with African American female STEM majors that I conducted, I selected 10 interviews to be used in this study. I attempted to diversify my sample by selecting participants from a HBCU and a PWI. I specifically selected these institutions because they both have an extensive offering of STEM majors so it would be more likely for me to find African American women who were represented across science, technology, engineering, and mathematics. Five of the participants attended one of the HBCUs in the UNC system and the other five were taken from one PWI. Additionally, I selected students were represented in life sciences, physical sciences, technology, and engineering. A list of participant demographics can be found in the findings chapter of this study. I also selected participants that made some mention of family in their responses given the nature of the research.

Background Information

Ten African American females between age 21 and 25 participated in this study. They represent a sample of students taken from a NSF study which analyzes the underrepresentation of women and minorities in STEM. The participants were selected from two universities within the North Carolina system. One is classified as a predominantly White institution while the other is comprised of mainly African American students. Among the participants, five were engineering majors, one was a physical science major, another a technology major, and three were life science majors. Only seniors and one junior participated in this study. This allowed for a measure of success based on persistence within a major instead of a more traditional measure of success such as grade point average.

All of the women, with the exception of one, reported their intent to seek careers in STEM-related fields. Among those fields engineering and medicine were reported most frequently. Six of the women will be the first in their families to receive college degrees in STEM and four of those six will be the first in their families to receive any college degree. All of the women were involved in commitments outside of the classroom in the form of jobs or campus organizations. A summary of the background information of the participants can be found in Table 3.1 below. The following section introduces the individuals who participated in this study. None elected to choose their own pseudonyms, so I chose the pseudonyms for them.

Table 3.1

Participant Background Information

Alias Name	Major	Year	Type of School	GPA	Career Goals	Employed	First Generation	Family with STEM Degree	Age	Club Involvement	2 Parent Household
Brittany	Chemistry	Senior	PWI	3.1	Nurse	Yes	Yes	No	22	Yes	No
Sasha	Information Technology	Senior	PWI	2.1	Unsure	Yes	Yes	No	25	No	Yes
Ja'Netta	Civil Engineering	Senior	PWI	3.77	Structural Engineer	Yes	No	No	23	Yes	Not with Biological Father
Pam	Systems Engineering	Senior	PWI	2.95	Systems Engineer	Yes	Yes	No	21	Yes	No
Tanesha	Mechanical Engineering Technology	Junior	PWI	2.5	Engineering Management	Yes	No	Yes	21	Yes	No
Bridget	Electrical and Computer Engineering	Senior	HBCU	3.22	Government Contractor	Yes	No	No	23	Yes	Yes
Angel	Biology	Senior	HBCU	2.7	Doctor	Yes	No	Yes	22	Yes	Not with Biological Father
Tracy	Biology	Senior	HBCU	2.89	Dentist	Yes	No	No	21	Yes	No
Nicole	Laboratory Animal Science	Senior	HBCU	3.14	Veterinarian	No	No	Yes	22	Yes	Not with Biological Father
Lauren	Chemical Engineering	Senior	HBCU	3.51	Chemical Engineer	No	No	Yes	22	Yes	No

ANGEL. Angel comes from a family that went to school at a local HBCU. Both of her parents graduated from there, and all of her siblings have or will graduate from this HBCU as well, so she considers herself to be legacy. Her older brother graduated with a degree in Chemistry so he has been an academic support system for her and he also kind of dissuaded her from majoring in Chemistry based on his own challenging academic experiences. Angel enjoyed math classes in high school, but a bad experience in Calculus in college made her rethink any thoughts she may have had about majoring in math. This is her fifth year in college because she failed so many classes in her first year and had to take classes over. She wants to go to medical school so that she does not have to struggle in life and so that her kids can go to the college they want to. She attends college on a full financial aid package with no loans to pay back.

BRIDGET. Bridget had an idea from a very early age that she wanted to be engineering major. She did a lot of research when she was in high school and the amount of money that engineers make was a deciding factor for her. She considered education at one point because her sister is a teacher but she wanted to make more money than educators. She experienced some difficulty with her Calculus class, but overall once she got the hang of college she did better in her math class because her university requires engineering majors to take more math. She decided upon computer engineering as a second major because of some difficulty she had in some electrical engineering courses. The programs are so similar that she only needed a few extra courses for the engineering major so instead of taking other electives she just picked up the computer engineering courses. In fact she plans to use her computer engineering degree when she graduates and has a job already lined up in that field. She is not sure if she will ever pursue a job in

electrical engineering but it would have to be one that did not require her to sit in front of a desk all day.

BRITTANY. Brittany completed most of her college experience at a HBCU that is in the North Carolina system but not used in this study. She transferred to the PWI selected for this study to help take care of her sick mother. She seemed to like her experience more at her previous university because it was a smaller school and provided the programs and support she needed to be successful in her Chemistry major. She came in originally as a Biology major, but switched to Chemistry because it was more hands-on. She has been very involved in high school and college with working and extracurricular activities. She has even had the chance to travel internationally and present her research at conferences. She talked about the struggles she faced growing up and being family oriented, yet she didn't always feel supported by her family. She had not mentioned religion until I ask about it at the end of the interview, then she talked about how much her spirituality influenced her life and assisted her in pursuing her major.

JA'NETTA. Ja'Netta already holds a bachelor's of arts degree in science, and the civil engineering degree she is currently pursuing will be her second degree. She described herself as a military brat and her family was stationed in a North Carolina military base. Her biological parents divorced when she was young and her mother remarried. She described very racialized experiences in her civil engineering program. She said it was difficult to experiences some of these situations because her parents raised her not to treat people differently. She described a troubled relationship with her mother because she felt like there were times her mother tried to take credit for her academic success even though she didn't really support her academically when she was in school.

LAUREN. Lauren considers herself to be different from the typical engineering major in that she is able to communicate well with others. She mentioned developing an interest in engineering at an early age by taking things apart and trying to put them back together again. She has had a lot of academic preparation in science and math which was in part due to her attendance at a science and math focused high school. She is in her 5th year and she has been able to participate in several co-ops and she even studied abroad in Hong Kong. She has received so many scholarships that she gets a refund check just from the extra scholarship money. She was recently submitted as the top engineering student from her department. She feels that if she would have attended another university she would have gotten a better quality of education, but she feels just as prepared as other chemical engineering majors in her ability to critically think about and assess problems.

NICOLE. Nicole constantly expressed her love of animals which has been the most influential factor that has driven her to become a laboratory animal science major. She talked about not being good at math and not really enjoying chemistry as a result of her dislike for math. She cited an incident with the chair of her biology department which resulted in her switching her major to laboratory animal science. She mentioned that it was difficult to discuss her major with family because they were either disinterested or they got frustrated when they didn't understand what she was talking about. She enjoys classes that provide hands-on experiences. She thinks people of different races have different experiences pursuing laboratory animal science majors.

SASHA. Sasha sees herself as more of a math person even though she is a technology major. Ultimately she sees herself in a career that involves finance and working with numbers. She knows that there is some stability with jobs in her career, but

she is not passionate about those jobs and she sees her major as an avenue to pursue the finance aspect she is more interested in. Sasha transferred from an HBCU to a predominantly White university and she cited some of the differences in terms of what it was like pursuing an information technology major. She brought up this calculus class in college that she struggled with several times. She took it twice and even cited it as one of the reason she didn't pursue a business major. She referenced feeling like she was intimidate by her professors and she didn't really see herself as belonging in her major courses as a female or an African American person.

TANESHA. Tanesha was my very first interview, and she has a very special place in this study. She was raised by her grandmother because her father was in and out of jail and her mother was not fit to raise her. She talked about the struggle of growing up in poverty and having to care for multiple siblings. She discovered in 7th grade that she wanted to become and engineer so she started doing her research. Tanesha did not consider universities far from home because she needed to be close to her family. She seemed very unsure of herself at times during the interview and admitted that she felt she suffered from low self-esteem.

TRACY. Tracy had a real disdain for math. She thinks it is because she didn't have a good foundation in it growing up and she never had anyone who could really help her with the subject so she struggled quite a bit and even avoided certain math classes like pre calculus and calculus in high school. She said she wished she would have known she needed those classes for college, but her guidance counselor didn't tell her she needed them and her family didn't know she needed them. There was a very poignant moment in the interview when she explained that she felt like White people had an easier time

majoring in Biology because they came from two parent households with parents that were educated and so they were prepared for college classes. At the end she changed it to reflect more SES than race because she said that maybe even African Americans or Asians that came from financially stable homes would do better. She felt pressure to finish her degree so she could become a dentist and be able to take care of her family.

Data Collection

Data was collected via interview. Exactly 10 African American females were interviewed during the course of this dissertation study using a semi-structured interview protocol created by myself and grant research team. The initial interview protocol was developed from the NSF grant quantitative findings and guided research questions taken from the STEM education literature. From this point the protocol went through several iterations before it was tested on junior STEM majors at a local PWI. Additional revisions were made (post pilot interviews) to the protocol before the final version was used in this dissertation study. The interview protocol appears in Appendix C.

The semi-structured interview protocol sought to obtain descriptions of the interviewees' lived experiences, similar to an everyday conversation. However, as a professional interview technique it has a purpose and involves a specific approach which transcends that of an everyday conversation (Kvale & Brinkman, 2009; van Manen, 1990). The interviews lasted approximately 60-120 minutes in length. The interviews were guided by but not bounded by the interview protocol. Specifically I probed when a particularly interesting response require elaboration.

Recently, computer-assisted interviewing has become especially wide-spread (Couper & Hansen, 2002) and this form of qualitative inquiry has a number of

advantages including increased opportunities to talk to people who are geographically distant from the researcher or located in dangerous places (Elmholdt, 2006). The interviews were conducted via telephone and in-person. The interviews were audio recorded so that a MP3 file was created and transcribed at a later date. To account for potential researcher bias and to work out the glitches of the protocol and interview technology, the research team piloted the interview protocol with juniors (60-89 credit hours) from a local university in the Fall of 2012. My previous piloting of the protocol with African American women also assisted in the development of the final protocol. The final protocol (Appendix C) was created using guiding research questions and quantitative findings from the NSF study. The final version went through several iterations before it was approved by the institutional review board for use.

I recorded all of the interviews used for this dissertation study. A professional, paid transcriptionist, hired by the NSF team, completed the transcriptions for this study. Once transcripts were complete, I followed along with the transcript while listening to the corresponding audio file to check for accuracy. Audio files and transcriptions were kept secure on my password protected laptop computer. Once transcriptions were completed and they passed through a member-check (a process that allows participants to validate the authenticity of the findings), audio files were deleted. A summary of the data collection procedures appears in Table 3.2 below.

Table 3.2: Data collection procedures

Data	Source	Method	Procedure
Rich descriptions of how participants perceived the influence of institutional and familial factors on their experiences as African American female STEM students	STEM students with 90 credit hours or more at the 16 universities of the UNC system	Semi-structured individual interviews conducted by phone or Skype	1. Create interview protocol 2. Pilot the interview protocol with junior year STEM majors and family members and friends 3. Revise the interview protocol to meet the needs of the grant and my individual research questions 4. Secure student emails 5. Compose screening survey 6. Send out screening survey via email 7. Send follow-up email to students willing to be interviewed 8. Schedule interviews 9. Obtain consent and conduct interviews 10. Transcribe interviews 11. Provide transcript to participant for a member check and to select a pseudonym 12. Import transcripts to Atlas.ti 13. Analyze data 14. Present findings

Data Analysis Procedures

In the proposed study, it is important to incorporate the data analysis process into the study once data collection begins. The goal of this study is to gain a better understanding of the familial influence on African American women's experiences in STEM while using participants' responses to answer the guiding research questions. The nature of the research questions in this study called for an analytical method that is not bound by numerical standards that limit the scope of the data collected (Creswell, 1994).

Qualitative data analysis is an iterative process that involves re-reading, rethinking and reinterpreting data (Glesne, 2011). Therefore, this process will require me to "be comfortable with developing categories and making comparisons and

contrasts…open to possibilities and see contrary or alternative explanations for findings" (Creswell, 1994, p. 153).

Coding Interviews

Before I began coding I engaged in the first step of the modified Stevick-Colaizzi-Keen method described by Moustakas (1994), which was explained in the subjectivity statement of this dissertation. Throughout this process and the remainder of the analysis I engaged in a bracketing process to ensure that my subjectivity remained at the forefront of the analysis. I wrote in my journal before and after interviews. The data was ultimately interpreted using thematic reflection (van Manen, 2007). In the second step of the Stevick-Colaizzi-Keen method, I read through all of the transcripts of interviews and research notes. This process was called a naïve reading and allowed me to identify significant statements and concepts, to develop initial coding categories, and to get a sense of the information and its overall meaning (Braun & Clarke, 2006; Creswell, 2003, 2007; Lindseth & Norberg, 2004; Patton, 2002). Moustakas (1994) referred to this a horizontalization of the data. I continued to reflect in my journal throughout these initial readings. At this point the transcriptions were sent to the participants for member-checks and one transcription was sent to a fellow qualitative researcher to establish an independent list of codes.

Coding is a process of identifying and labeling data linked by a common idea or concept (Gibbs, 2007). All codes were included in a master code list. Ideas and concepts that were recurrent and emerged in the descriptions of respondents' lived experiences as they relate to the research questions were highlighted (Braun & Clarke, 2006; Gibbs, 2007). I review the highlighted portions of the transcripts while assigning initial codes or

broad categories. I utilized ATLAS.ti, a qualitative data software tool, to facilitate the coding of the data (ATLAS.ti Scientific Software Development GmbH, 2009). As each quotation was assigned a code in ATLAS.ti by the researcher, the quotation was assigned an identifier that is composed of a primary document number to which the quotation belongs and a secondary number that identifies its location in the primary document (e.g., 30:2 corresponds to primary document number 30 and the quotation number 2 in that primary document) (Friese, 2011). My fellow qualitative researcher (another doctoral student from my program) engaged in a similar process.

My fellow qualitative researcher and I collaboratively reviewed the highlighted statements and our broad categorization of them. Together we compiled a final list of statements. These statements were then organized into larger units of meaning (Creswell, 2007). Subcodes of these units of meaning were also coded for in ATLAS.ti. Once the clusters of meanings were agreed upon, textural descriptions were written for each participant as they related to the phenomenon of study. Additionally a textural composite description was written transversely among participants to demonstrate the shared meaning among the women. Textural descriptions included examples of *what* the participants experienced in relation to the phenomenon (Creswell, 2007). Additionally, structural descriptions were created to describe *how* each participant experienced the phenomenon (Creswell, 2007). Finally, textural and structural descriptions were combined to provide an overall or core description of the phenomenon (Creswell, 2007). This is a description of the essence or nature of the phenomenon that was experienced by the participants in the study.

Themes were shared with participants as a form of member checking (Flick, 2007). After conducting interviews with the participants in this study, I emailed each participant individually to explain the process I used to interpret the data and present my initial findings and themes. The aim was for participants to be able to recognize their experiences in the initial findings and themes and offer participants an opportunity to provide new insights to better capture and explain their experiences (Merriam, 2002). Out of the 10 participants, only 4 responded to the email with the attached transcription. Two of the women wanted to provide clarification to a comment they made during the interview process, but it was nothing detailed enough to require a new code.

Strategies for Quality

Qualitative data analysis is an interpretive task. According to Ezzy (2002), "Interpretations are not found—rather they are made and actively constructed through social processes" (p. 73). Therefore, I made an effort to diminish any potential bias that could have arisen during the study. In order to mitigate my own bias and increase the credibility of this study, I utilized the following techniques: 1) debriefed regularly with my committee chair and other committee members, 2) performed member checks with participants to validate the accuracy of the findings to their lived experiences, 3) kept a journal or memos during the entire analytic process, and 4) debriefed with a colleague who was also qualitatively trained and can provide her own interpretation of a portion of the data. These steps were essential to establishing the credibility of the study and maintaining my focus as a researcher during this process. This focus aligned with the theoretical framework of the study in that it accounts for the importance of relationships

between me and the participants which is critical in feminist standpoint methodology (Ezzy, 2002).

Summary

Chapter Three began with an overview of the research purpose and research questions, a brief summary of qualitative research and its use in this study, an overview of phenomenology and the rationale for the use of this particular research method, and a description of the research design and procedures. The research procedures portion of this chapter includes an explanation of participant recruitment, data collection, data analysis, strategies to ensure the quality of the study, and limitations of the study. Phenomenology is a suitable methodology for this study because of the lack of qualitative studies investigating phenomena involving African American women in STEM and due to the nature of the research questions which are, "What are the experiences of African American women in undergraduate STEM majors at the 16 public universities in the state of North Carolina? How does the designation of predominantly White institutions versus historically Black colleges and universities affect those experiences? What role does family play in the experiences of African American women undergraduate STEM majors?"

Following the sections outlining the use and rationale for qualitative research, the chapter detailed the data collection and analysis procedures. The data collection section provided an overview for the NSF study which guided this dissertation study and it outline participant selection and data collection techniques. The next section explained phenomenological data analysis procedures and strategies to ensure quality of the research. The last section discussed the limitations of this study.

CHAPTER 4: PRESENTATION OF RESEARCH FINDINGS

This chapter presents the findings from this qualitative study investigating the familial and science identity factors that influence the success of African American females in STEM at two universities within the North Carolina system. To investigate this issue I conducted 10 interviews with African American female STEM majors. I analyzed data for emerging themes using thematic analysis. In interpreted my findings through a critical race feminism theoretical framework which is discussed in chapter 5. The following research question guided this study:

1) What role does family play in the experiences of African American women undergraduate STEM majors who attended two universities in the UNC system?
2) What factors impact the formation of science identity for African American women undergraduate STEM majors who attended two universities in the UNC system?

Factors Affecting STEM Experiences

Factors affecting the participant's academic experiences were divided into the following five themes: (a) independence, (b) support, (c) pressure to succeed, (d) adaptations, and (e) race and gender. Independence factors included responsibility and negligence. The factors identified within support consisted of types of support (financial, spiritual, positive academic support, and lack of academic support) and functions of support (encouragement and motivation). Pressure to succeed did not have any

subcategories. The adaptations theme included two sub factors of self-confidence and doubt. The race and gender category included the following factors: “a fish out of water”; STEM intellect; perceptions of professors; lack of cultural responsiveness; opportunities; and sexism. All of these factors are interrelated and worked together to influence the academic outcomes of the participants in this study.

Independence

Independence was a pervasive theme that appeared throughout the findings. Independence emerged in response to how the participants in this study were socialized within their families. Even though there were no direct quotes used to establish the link between independence and STEM experiences, a discussion of the previous literature in chapter five suggests that African American families promote independence among African American females so that they can persist in challenging situations (i.e. pursuing a STEM major). Respondents spoke about how they have asserted their independence when the situation called for it. For some independence surfaced out of the responsibility or support they felt toward their families while others learned independence as a result of negligent parents or sacrifices that had to be made.

Responsibility

Tanesha learned to become responsible for herself and others at a very early age. Her grandmother encouraged her to become independent in order to take care of herself and in turn her independence was transferred to the care she provided to younger siblings. She spoke about how her relationship with her grandmother has influenced her independence in the following passage:

> Well, my grandmother raised me. My dad was in and out of jail my whole life. He is in prison now. My mother wasn't fit to raise me and my brother or sister so I went to live with my grandmother and my grandma raised me from 7 until I was 18. You know being raised by my grandma I think made me so independent because you know she told me "I'm not your mother you know I'm your grandmother and there is no guarantee that I'll be here forever." And that's just the way she raised me like to stand on my own two feet and you know to never let anybody take advantage of me and have my dignity and my self-respect.

Brittany also learned to become independent out of responsibility to her family members. She worked all through high school as a personal care assistant (PCA) so that she could contribute financially and also take care of her sick mother.

> It was before I left for college. She [her mother] was very sick. I worked for this company. I don't know if you know what the name of it, but it's called Pacific Coast and it's basically where you have like, you could have like patients all over Arcadia. I did this for a while in high school. You can have patients that you find or you go in their homes and you take care of them, you know, some of them will say "cook. You can cook these foods or you can vacuum or wash my clothes or whatever." So I did that for my mom and other people. It's called personal care assistant so I was a PCA for like a year and then as my mom sicker I took care of her, so I changed her would bandages. I did everything that, like, sometimes the nurses

> didn't need to come out cuz I had already done everything that a nurse could do.

Negligence

Ja'Netta does not recall her mother being very hands-on in her academic experiences growing up, yet her mother took a lot of the credit for her academic success when she went to college. She also talked about the differential treatment her mother displayed among her five children. Ja'Netta said that she took the brunt of her mother's scrutiny, where as her older sister, who was not as academically inclined, was less likely to be chastised. When asked about the relationship with her mother she responded as follows:

> Well me and my mom wasn't too close growing up and she started trying to participate more towards the end and that made me angry. So when we got to the campus it was orientation. She was going around talking to everybody, "my daughter this and my daughter that and we worked so hard" and we did this and I was like "you were never there, you don't even understand what I'm going to school for, you didn't help me with these applications." My boyfriend at the time, his mom took me on college visits; his mom helped me with applications. The student counselor was the one to fax the applications whenever the deadline was that day. "I had to beg you to even pay for some of these applications;" most of them had a waiver, other one's my boyfriend's mom paid for, so I was like "you haven't done much but yet you're walking around how most people are

> being a proud parent" but I felt like she was taking so much credit and just being something that she's not.

Overall, Ja'Netta felt that her mother was negligent in some areas as a parent. Growing up she did not assist with homework and she was not very helpful in the college application process. Hrabowski (2002) lists several specific ways that African American mothers help their daughters academically. Among them was reading at home, checking homework, giving unconditional support, seeking help when needed, encouraging questions, and providing a variety of intellectually stimulating in-home activities. Ja'Netta did not describe her mother as being the type of person to engage in these types of activities with and for her children. Nonetheless, Ja'Netta learned to become independent and seek out from other kinship such as her Godmother.

Sacrifice due to negligence was a term that other participants could relate to as well. Pam also understood what it was like to sacrifice for the sake of the women in her family. She assumed the responsibility of her younger sister at an early age and experienced a constant tug-of-war between going to college and providing a better life for her family or staying home to look after her sister.

> I had a lot of family problems, like not necessarily being a family. My father passed when I was 12 so all I have is my mom and my sister, you know it's us. We've been together it's just always been us cause my dad lived in Ohio he didn't live with us or anything but I went to visit him like around the summers so like um my mom was going though this like phase I don't know like maybe it was a mid-life crisis, who knows, but honestly we were like homeless for 5 years. We stayed with my grandma for maybe

> a year, stayed with my cousin for a year um just kind of like bouncing from house to house and it was um I need some stability in life and I just could not deal with Oldtown, the point where I just had to get away but at the same time I got a little sister and that's my baby girl so it was like "do I wanna leave her?" But they [family] always told me, "you going away to college and becoming an engineer is making a better path for her."

Pam gave up a lot in her childhood to be a support system to her family. She had to become very independent so that she could help provide stability to her family.

> I'll tell you one thing; it's funny but at the same time not funny. My sister I'm her dad. They say "who your daddy? Pam, that's my daddy." My mom, we only have one car. So I'll take the car and she'll go to work, she'll go to school and I go to work or whatever. Well sometimes I'll get a call like "oh you forgot to pick your kids up on time," so my mom and my sister are my kids. Those are you know my children, I'm the mom. I got a little sister who growing up without a father as well, so it's like what about her I gotta you know still be strong for her, be strong for my mom because you know how she don't have anybody to go to, she don't a have husband you know anymore, it's like what do we do? So it was kind of like stepping up you know being what they needed me to be at the time they needed me.

Two primary points can be deduced based on the relationships these women have with the female family members in their lives. The first is the considerable amount of independence these women have had to assert over the years. Many of the participants

make daily sacrifices to support female family members despite the ambiguous nature of the relationships they have developed of the years. The ties these women have to female family members will be instrumental in discussing the identities these women have developed over the years in relation to themselves and others.

Support

All of the girls reported feeling supported in their pursuit of a STEM degree. The degree of support varied from participant to participant and there were even times when the women found it difficult to articulate the type of support they needed from family.

Types of Support

FINANCIAL. Quite a few of the participants in the study came from disadvantaged backgrounds. Even those who came from more financially stable homes still struggled to pay for college. Lauren spoke about the support she received from affluent church members within her community.

> I have quite a few church members who are affluent within the community or they attended my university and terms of the support they provide, they provide monetary support. They provide monetary resources.

Tracy's father was in and out of jail the majority of her childhood so he was unable to support her emotionally and academically. She did mention that he attempted to support her financially after she asked him. She felt like that was the least he could do after being absent so many years. Even though Tracy's father did manage to contribute financially to some degree, she did not really consider him to be a significant support system in her pursuit of her STEM degree.

> He has nothing to do with me pursuing biology. He has no influence in my life honestly. I'm not upset with him; I don't really care about him. That sounds really bad. He doesn't influence anything in my life. I was a freshman in college, and I would ask him "hey can I have 40 dollars to buy me some food." I felt like that was the least he could do. "You haven't been in my life, why can't you send me a little bit of money to get by. I'm in college, I'm trying to better myself." He would do it, he was like "that's fine." A month later, he would stop talking to me and stop texting me. It made me feel like I didn't really want to involve myself with him anymore. Then he would pop back up six months later after he got out of jail for something.

SPIRITUAL. Religion was a concept that came up quite often in the findings of this study. Lauren spoke about similar experiences of receiving spiritual support from her church family. When she received calls from church members they would encourage her through messages like those displayed in the following passage:

> When you start something, you finish it. You can do anything that you want to do. You can go as far as you want to go regardless of what hurdles are there. If you put forth you know effort and work it will pay off." Also a lot of Christian family values about the Lord you know taking care of you. You know trusting in God for a lot of things, like faith and belief in you know how the Lord gives certain skills and gifts to people and exercising in those gifts and skills that he's instilled in you. I'm trying to think…treating people with respect. Also communication, being able to

> communicate with people of all walks of life, all types of socio-economic backgrounds, all types of races, all types of religious backgrounds, all types of ages, genders.

Nicole also received spiritual advice from church members. Nicole talked about how her campus ministry organization provided support to her. She said that not only did they provide spiritual support, but they kept her on track academically.

> There has been times where I've had so much on my mind. I mean, just personal- personal things to the point where I can't really focus on my academics and you know I call or text them [church members] and they come over or meet up or something, talk about it on the phone, you know, pray, fast, you know, whatever. Whatever we need to do to. Take it to God and say the issue to God and, you know, deal with it like that and they encourage me as well.

Positive Academic Support

Academic support was cited most often in the types of assistance participants received. The women talked about the academic support they received from their families in different ways. While some of them felt very supported by their parents academically others did not. Bridget talked about she built with her brother over the years through their academic/play interactions. She actually credits her brother as the reason she became interested in STEM.

> I can remember I used to sit and watch Discovery Channel. My older brother was into technology, I'm gonna assume when I was younger he probably pulled me toward technology. I can remember him being

> frustrated trying to figure out how to do one of his transformers and showing me, me thinking it was so cool that they were able to make something that could change shapes as a little kid. Um I think those were some of the factors that led me to get interested in it.

Sasha described the positive academic support she received from the male family members in her life. Like Bridget she formed some of her closest bonds with family members through the positive academic support she received. Here she describes an experience when she and her father worked on math problems.

> I'm a daddy's girl and I'm a granddaddy's girl so that just really sticks out to me, um, that pretty much- but I always liked math, I don't know why. Pen and paper- well pencil and paper and I'm fine but I think if I had to think about like my favorite times doing math it would probably be with my dad. We were really close.

After the death of her father, Sasha solidified other relationships with the males in her life. Her grandfather was a constant source of support and the relationship she had with him was in part the reason she decided to attend a university closer to home. Her uncle was a big support academically as well. In fact he currently holds a job that Sasha could possibly see herself doing once she graduates with her degree in information technology. When I asked her about the academic support her uncle provided she said the following:

> My uncle, he's pretty much like a brother. We're ten years apart and he's been around since, like he was like the first person that really made me think college was even possible. Like, I mean, he's done everything from help with homework to like- like, when he does his work sometimes he'll

> like send me stuff or like, he'll find cool stuff and just send it to me like you might need to know this. He's very up to date with what's going on. And we talk pretty regularly. Like at least a good once a week just to see how everything is going and everything like that besides texting and stuff like that. Right now he works for Verizon doing- I want to say he does like customer help as far as like working with their phones and stuff which is another thing that I could do but. And also he's always been like a role model for me so he kinda comforts in the fact that this may be what I do for the rest of my life.

Lack of Academic Support

Although the women cited several experiences of positive academic support, most of it occurred when the participants were younger. As the women entered into advanced courses in high school and college, the amount of academic support their families were able to provide was limited. The women who reported not feeling supported at times often cited a lack of academic understanding as the reason for their frustration. Brittany, Ja'Netta, Tracy, Nicole, and Angel all said that they too felt supported by their families in the pursuit of their STEM degrees; however, they expressed a lack of support to some extent. Brittany referred to herself several times over the course of the interview as being very family-oriented. She talked about getting together for holidays and sitting down over a home-cooked meal. However, when it came to her academic studies, Brittany often felt avoided by her family due to their unfamiliarity with her major.

> They supported me in going to college but they weren't necessarily really able to support me in pursuing chemistry because they didn't know much

> about it themselves. I look at them as supporters but when it comes to my academics they're not really there, like, nobody can really, I don't know, they just like, you know, it doesn't matter to me whatever you do, you know. I wouldn't mind, you know, just sometimes simply just having somebody to talk to, you know, about what I'm going to do when I graduate or if this doesn't happen then what, you know, cuz I don't want to graduate and be working at Papa John's. You know what I mean?

Nicole expressed a similar frustration when attempting to have conversations with her family about the specifics of her major.

> It's interesting to them but they really haven't said much about it, I mean, they know that I love animals and, even when times that I would love to talk about my major to my family but they don't show any interest or enthusiasm about it with me; therefore, I just stopped talking to them about it. There have been experiences where I would talk about something but it's so disgusting to them and that would be the one point where my mom got pissed off at me for even talking about something and I was like, "oh God, ok, I guess I can't talk about it anymore." Just even talking to my sister about something in my major and I was talking in terms that she didn't understand and she got an attitude about that which I didn't…sometimes in your major you don't realize. You've used the terms around your department for so long, it's like when you talk about it to somebody else you don't realize that you're actually saying terms that they've never learned, that they never understood and she got mad at

> me, and I didn't know. I was just, I mean, you know, I was just foaming at the mouth and I didn't stop to think and, you know, that just lost my interest in actually talking to my family about it. So other people that are interested in my conversations about my major and, you know, that's when I get really happy when I talk about it more but, I mean, I guess my family feels indifferent about it. Like the, you know, it's just kinda like, "ok, you know, that's cool, that's- that's fine, ok."

Tracy attempted to have a breakthrough with her family several times about the demands of her biology major, but the apathetic responses she received from family members often left her feeling less than supported.

> I feel like they don't understand. Like I said sometimes they'll tell me "It will be alright blah blah blah." I just want to say "no it won't because you know; you haven't taken these hard classes before." A few of my immediate family members went to college, but they majored in family and consumer sciences. Things that are just easy to me. I could definitely go into a major like that and be making straight A's and B's, no problem. If you're not taking the type of hard classes I'm taking you're not going to understand. I feel like anybody can go and do a social work major or a speech major or a family and consumer sciences major. Anybody can't do biology like that; it's hard. I try to explain to them, they say "we know it's hard…blah blah blah, you'll get through it." Sometimes I just want to say "No. Shut up. You don't know what you are talking about." I just listen

> to their encouraging words and get through it somehow. I don't know how, but I do.

Overall it appears that the women in this study received various types of support that were conducive to succeeding in STEM. Even though some of the participants did not always feel supported academically, they were able to acknowledge the positive messages that were infused in their family's lack of academic understanding of their majors.

Functions of Support

The support that the participants in this study received from family, friends, and community and organization members served as encouragement and motivation for them to be successful in their majors. The interviews revealed that encouragement from family members and others was an important factor in influencing the academic success of African American college students.

ENCOURAGEMENT. Tanesha spoke candidly about the support she received from her grandmother and best friend. She reported that the support she received was a 20 on a scale of 1-10. When asked how she was supported she responded with the following:

> It's so many times where I feel like I just I just can't do it or I'm just so stressed out. You know there have been days where I called my grandma crying and I'm just like "grandma you know it's so hard you know I didn't do as well on this test and stuff." And it's just all about encouragement. You know telling me that you know I can do it that there's nothing that I can't do. So to say that I can't do it you know my grandma calls it crazy

> talk you know. She'll start preaching to me and stuff "you know you can do all things through Christ that strengthens you and you can do it" you know. My best friend you know she tells me you know "Tanesha you don't give yourself as much credit as you deserve." I tell Shell you know "why do you put up with me or whatever" but it's all about not giving up like you know they haven't given up on me. It's consistent encouragement because you know I've had some people that were with me in the beginning when I did this and you know they were so excited I was coming to college to do engineering and you know they are only going to be there when I graduate. It's about the people that are there while you're doing it you know because that's what matters. You need something to keep you going you know everybody wants to pop up once you graduated you know you want to share this moment with me but you didn't share what I had to go through to get to it and they're there so.

When Bridget experienced discouraging moments her family was there to give her a pep talk. She was reminded that education was a very valuable asset and they key to being successful in life.

> Last semester I took 20 credit hours, it was really stressful and I would call home and be like I can't do this and I don't wanna do this and my dad would be like "yeah you can do this you got this far, you know you can keep going, you're almost done, you know you'll look back on this and be like that wasn't nothing" and so he gave me this big pep talk about how I can do it and I got to keep pushing through and it helped me out. He

> reminded me that the key to being successful in life is to have education, be successful in education, have a higher degree and you can get what you want and what you need.

The encouragement the participants received from their support systems is similar for other African Americans who major or do not major in STEM. I cannot conclude from these findings that the encouragement these women received directly related to them being STEM majors, but the encouragement did serve as a positive influence for the women to persist in the majors.

MOTIVATION. The participants in this study used motivation to keep them going in very demanding STEM fields. Pam gushed about her friends from back home who served as a welcomed distraction to all of the studying. Brittany recalled a time when she considered changing her major and her friends responded with the following support.

> They would be like, "no, Brit, you can do this. Really. If anybody can do this it's you because you have your head straight. Like, you can really do this," and a lot of times I think that's kinda another thing that kept me going. They kept me motivated. Like, if everybody else think I can do it, why don't I?

Pam cited her family members as a form of motivation.

> I got a little sister and that's my baby girl so it was like do I wanna leave her but they always told me, "you going away to college is making a better path for her." I thought about dropping out of school to move back home and work so I could take care of her so we could have a place to live, you

> know that's my baby girl. I couldn't let her be out there by herself but my mom's best friend ended up taking my sister and letting her live with her. She treated us as her own children so it was ok. At that point it was like let me just get through school and finish and graduate so I can take care of her.

Tanesha also used her siblings a positive reinforcement. She was also motivated by making history in her family as the first person to have a career instead of a job.

> I come from a family that really have no education. I mean they have like degrees where they've went back and gotten them. Nobody that's really went to a four-year university got a degree and you know started a career. You know there is a difference between having a job and having a career. So, then when I think of it I think you know well I can make history in our family. I don't want to be that extreme but that's my motivation. Um, let me mention I do have four younger sisters and two younger brothers. So, they are my motivation too. I try to be the best role model I can be.

Motivation is a difficult construct to measure. I cannot presume that these women were more or less motivated during the college experience than other college students. What they did suggest through their stories the extrinsic form of motivation they utilized to persist in their majors.

Pressure to Succeed

All of the women in this study feel a pressure to succeed that is directly linked to their families. The majority of these women feel a financial pressure from their families while some cite setting an example for their younger siblings as the need to finish their

degree. Pam discussed the need to succeed as a way to get her family out of their current financial situation. Sasha talked about making good on an opportunity that other family members had not been afforded. Ja'Netta and Angel were afraid of disappointing their families while Bridget felt the constant push to be perfect. Brittany's drive came from the need she felt to financially support her sick mother and her little sister. She even decided not to go to medical school but become a nurse, because her family demands would not allow her to keep up with her academic demands. There are several excerpts below which describe how social capital intersects with the pressure participants' feel to succeed.

Tanesha joked during the interview about being able to buy her grandmother a house after she becomes a mechanical engineer. Aside from the financial benefit to her family, Tanesha discussed an innate responsibility she feels to succeed in her major.

> So, when it comes to this major it's something that a lot of people say that Black people can't do and that girls can't do and I'm doing it you know. So, it's a very big accomplishment to have made it this far and like everyday I'm like I just don't want to do this anymore. It's so hard but I'm like why would I give up you know like I have like a year and a semester to graduate so um I'm really happy. I'm more happy about what's going to happen when I do graduate.

Tracy discussed the need to prove her critics wrong and inspire other family members to follow in her footsteps. People in the community in which her family lives have told her family members on several occasions that she was not capable of becoming a doctor.

> Maybe one thing that I will say is the reason why I feel that I have to do so well in my major is so that I can be successful in my career. There are no doctors in my family. I will be the first doctor in my family. I feel like that it puts pressure on me to do well. I want to do well. I want to always study and be on top of things in my major because I want to make my family feel if she can do it, somebody else can be a doctor. I'm going to be the first doctor I want to do well. And there are people that have told my family I can't be a dentist, or I can't get into dental school, nobody will tell me who says it, but my aunt told me someone said they don't think I'm smart enough to be a doctor or a dentist. But she never told me who says it. I feel like I have something to prove to whoever said that I wasn't smart enough. I graduate this year.

These women feel the pressure to succeed as a result of the demands placed on them by their families or even as a result of their family's socioeconomic status. Even though some of the participants identify their individual accomplishments, their focus is more centered around giving back and providing a better life for their family members.

Adaptations

All of the participants agreed that majoring in STEM was very challenging; a challenge that all of them happily rose to meet. However, the identities of these women were shaped in various ways often times depending upon how they responded to their STEM environments. There were times when all of the women displayed a strong sense of self, but there were also times when they doubted their own abilities. The women were able to adapt to their STEM environments despite the challenging curriculum or being the

only female or person of color. Some of the women displayed adaptive qualities in the form of self-confidence while other

Self Confidence

The majority of the participants in this study have come from backgrounds and had life experiences that have required them to assert themselves in demanding situations. The participants spoke about having to be vocal and learning to articulate themselves when the time called for it. Pam credits her confidence to her upbringing. Having grown up in a family where she took on a motherly role, she finds it quite natural to speak up in situations where her voice is being excluded.

> Well I won't say discouraged because like I said I'm a very assertive person so I mean I've had a few situations where it's like you know what I say doesn't matter. My freshman year I ended up on team it was, what do you call it, it was like our freshman design project or whatever it was but I ended up on team with 3 guys and 1 other girl who was really quiet and all these guys-most of them were like very assertive as well and I think I was top of my class in high school and I know what to do, I've done something like this before. I'm a STEM major. So I kind of ended up, you know I would throw out a suggestion you know. "Have you looked into doing it this way or maybe we can do this, maybe we can do that" and I got shot down every time you know. It's like I don't know and like why you haven't even given it any thought but that honestly happens a lot where I can throw out an idea and they'll kind of be like "ok anyways next back to what I was saying, what I wanna do." So at times it's a little aggravating,

> that's what I would call it. More annoying because then you have to come out of character and kind of show up, you know show up like "look I understand that you feel like you have this under control but as a team I think we should definitely look into doing it different ways. Now whether we need to do a decision matrix for you to understand, for you to you know decide what you want to do, I think there should definitely be some coordination in how we choose to do what we're gonna do."

Pam talked about having to assert herself in group situations because she often felt excluded.

Lauren identified as someone who is not easily intimidated. She drew her strength mainly from her religious upbringing and the church family she relied on heavily for support. Instead of succumbing to situations where she was not the most knowledgeable, she displayed characteristics of persistence and confidence as well.

> I think it has made me a person who's not easily intimidated. Sometimes just because someone seems to have more than you or necessarily know more than you or you know perform better than you, you don't look it as intimidation. You can look at it as, "let me find out that's what they're doing" or "try to talk them and gain knowledge from them cause obviously they know something I don't know and maybe I should know it." You know it kinda makes you more hungry for knowledge and like learning something and I would also say it's just helped me in my courses in the sense that I'm a very confident person. I don't have to have people to like tell me oh you are this, you're that when I know it for myself

> because I know who I am in Christ so I don't need people to define me. When you lack confidence that can play out in many different areas in your life and so I've been able to maintain a strong commitment to my major cause I mean the whole 5 year journey hasn't been extremely easy. I've been in classes that have been very challenging. I've probably wanted to change my major at least twice in college you know but when you start something you finish. It has been one of things where I'm like I know my end goal and what I want to do with this major. Just cause it got a little hard I can't just up and give it up. It's not completely dead I just need to keep working. It'll come. It'll get better.

Lauren describes some of the challenging moments she experienced pursuing her degree in STEM and the times she considered changing her major as a result; yet she did not.

Unlike Lauren, Tanesha struggles with her confidence a little more. She described herself as typically being a very vocal person, but since becoming a mechanical engineering technology major she has toned it done a bit. At some moments during the interview she explicitly stated that she asserted herself frequently in her major, yet there were times when she also admitted to self deprecation. When I asked her how she adapted to her new environment she reflected inwardly.

> It was just a self-thing. I talked to myself. I said "Tanesha you need to step your game up and you're capable of just as much as those other students are. Perhaps you didn't have the best pre-education when you came to college you know so you don't know as much but that doesn't mean that this is downhill from here." You know it was a talk with myself.

Tanesha felt that her science identity was formed in relation to her race and gender, but she also described precollege academic preparation as a part of her science identity.

Doubt

All of these women have had to be really strong to persist in a major that not only is extremely challenging, but for some of them, an experience in which few other African American females have engaged (NSF, 2013). Some of the women were so close to finishing, yet they still seemed to be unsure of themselves in some ways. Brittany expressed doubt over her decision to major in Chemistry. Ja'Netta was unsure if her personality was conducive to becoming an engineer. Sasha thought about giving up because of her age and having been in college so long.

Angel expressed doubt after failing several classes in her freshman year, but she managed to stick with it and is about to graduate.

> Like it was fun and I didn't pay attention to my studies like I needed to and I ended up failing 2 of my biology classes and I got 2 D's in my chemistry classes my first semester here. I had 1.8 gpa at the time and that was just like oh my gosh. I thought, like, my mom is going to be mad and the whole community back at home is going to be disappointment. Like, and it was just gonna be embarrassing to have to go back home and it was just like should I even do this anymore? I can pick another major and it would be so much easier but it was just like I couldn't even decide on anything to pick. It was just like science has just always been that interest of mine and so I just stuck with it and now I'm about to graduate and my GPA is way above a 1.8 now but it definitely took a lot of work to bring it up but I knew I could do it.

Like Angel, Tanesha also expressed doubt after receiving failing marks in her freshman year of college. As stated above, Tanesha experienced quite a bit of anxiety when she left her grandmother to attend college. She does not seem to have completely recovered from her disappointing academic experience so there are times when doubt creeps in and as a result she settles for mediocrity. In order to avoid the disappointment she previously experienced, she sells her academic abilities short.

> Yeah, I studied hard because I'm trying to get an A and then I don't get an A so I'm like what was the point of all of that studying. So, if I know if I study you know just enough to get a B and I get a B that's what I did. So, and a lot of it is you know self-confidence or whatever. I've had times where I've studied you know really hard for tests and I don't get an A or B I get like a C or D and I'm disappointed you know so. It's a lot to do with me as a person, in general, and not just with me as a student so. I don't know what it is. I know I don't have low self-esteem but I don't think sometimes that you know I'm not as good as other people think I am. I don't know. It's nothing you know anybody ever put me down growing up or told me I wasn't good enough. It's nothing to do with that. I've never reached to the root of that. I can say that I've had that issue for a while just in school and my personal life, relationships, and I've never gotten to the root of it.

These findings reveal the self- confidence and doubt the participants encountered while trying to make sense of their experiences as a STEM major. As evidenced by the

findings, the experiences these women have had in STEM have shaped how their identities and how they respond in challenging situations.

Race and Gender

I expected that race and gender would emerge as pervasive findings in this research simply because all of the participants are racial minorities and female. What I did not expect was the divisive lines that would be drawn between the groups of participants. Those participants who attended the predominantly White institution experienced a more heightened awareness of race than those who attended the historically Black university. While all of the females acknowledged their racial minority status and the rarity of African American female STEM majors, the participants who attended an HBCU did not experience their race as negatively while pursuing their STEM major. Therefore the cultural dissonance the participants experienced as a result of their racial status manifested more so from the culture of the institution they attended as opposed to simply being a minority in a STEM major. The complexity of gender, race, institution type, and STEM is explored in the participants' responses below.

A Fish out of Water

The participants who attended the PWI expressed a sense of exclusion due to their minority racial status. This finding was not present among the participants who attended the HBCU. The women who attended the HBCU were more likely to experience isolation as a result of their gender status or the rigor of the STEM content. Below the participants who attended the PWI talk about feeling isolated because of race.

Pam stated that she would be the first African American to graduate from her engineering program at her PWI. She felt a great sense of pride about being the first, but

at the time she recognized the statement her accomplishment made concerning the lack of African American women in her major. Sasha was not at all shocked about the experiences she had regarding race. Being the only person of color was an experience she had gotten quite used to. In fact, she stated that she felt her racial status marginalized her more than her gender status. Sasha said, "I expect more that race would marginalize me so that didn't really come as a shock." Tanesha echoed the sentiments of Sasha when I also asked her whether she felt more discriminated against because of her race or gender.

> My race. Yeah, I can honestly say that if I've ever been in a situation where I just you know feel out of place it's only because [my race]-well I won't say only because but it's not a lot because I'm a female because we have female engineers in my major but they're white.

She described a classroom setting where cliques were formed based upon race with gender being the secondary factor of categorization. Ja'Netta experienced the formation of cliques in a similar way. In the following passage she reflected on the segregation that occurred in her major courses.

> I would say that people don't really break off but they connect a whole lot more easier to people that look like them, so you walk in a class you see the Mexicans in a circle, you walk you kind of see the White people kind of taking over but they're all connected somehow and I do it too. I walk in a class if I don't see anybody I know I'm sitting with the Black people. And it's horrible to say but it's like a comfort thing. I can relate to you. I know you were the only Black person in here before I walked in here so you know we can support each other. When you walk into a University of

> Arcadia engineering course you can spot the Black girl or the Black guy like they're in a cup of milk or something.

The discomfort Ja'Netta and the other participants describe about "being the only" was also found in Hanson's (2009) study of African American females in STEM. Hanson (2009) describes the discomfort as the participants feeling out of place in their STEM academic environments.

Tanesha also felt that it was easier, being a minority engineer at the University of Arcadia, to pair with other African American engineers when possible to avoid the coldness from other classmates. She cited several examples of moments when she felt excluded from the other students in her class based on culture.

> I came in one day and it was cold and I had a pink vest on and like everybody around me is in like camouflage. Like camouflage you know is like the stuff they wear when they hunt and that's what most of my classmates do. And I'm like just sitting there and I feel like I'm the prey or whatever but it's just very awkward to have to go into a room and be the only person of color. You know you don't have anybody. It was like that in the beginning but you don't have anybody to talk to. When we are assigned projects, we are split into teams and they weren't very receptive. It was almost as if they were talking over me, not like I was speaking and they were talking over me. I was sitting in the middle of two of my group mates and they were talking to each other over me.

What is important to note is that this is how the participants viewed their racial position in regards to others. These findings do not represent factual evidence that all of

the experiences were indeed influence by race, but for some reason this is how the participants interpreted their experiences. This has implication for colleges and universities regarding the culture of STEM programs.

STEM Intellect

All of the participants are bright, capable young women. They would not be on the verge of receiving degrees in some of the most difficult majors if they were not very intelligent. However, the participants at the PWI spoke about how they felt their academic ability was often questioned in relation to their racial status. Sasha joked about sticking out like a sore thumb in her new department after transferring to a PWI, but she felt that students did not want to work with her because they doubted her skill level. When I asked whether she felt it had anything to do with her race, she responded affirmatively. She went on to explain further.

> I'm inferior to them. The technical part is where I feel like they think that they're better than me. This one scenario sticks out my mind where we were assigned group work and we had to do a paper and present. it was a networking project and I was the only Black person in the group. It was like a group and I think there was four or five of us. I was the only girl and it was four white guys and I ended up being the person to do the paper. They gave me no responsibility whatsoever with the project. They just told me what they did and shot me the information and I was just supposed to write the paper. I'm pretty sure they probably had meetings where I wasn't even there cuz I was like "where did all this information come from?" I

> kind of assumed like, maybe this is what I have to deal with in the working world.

Tanesha displayed understanding when she discussed her classmates not always understanding her because they came from towns and cities where they did not have to interact with African American people. She said it only became a problem when she needed to have an academic opinion for the betterment of the group and they were not receptive. Ja'Netta had a similar experience when her classmates doubted her academic ability.

> Oh even today like in my Civil Engineering program there's majority Caucasian males so I make a lot of associates and stuff, we sit in there talk and have fun. I tend to be a real laid back person so most people get along with me. They'll say something along the lines of women are typically not going to be able to handle a job that the guy could so you know they'll be inside an engineering firm at the desk so you won't see them so much in the field or you're going to get a job because you're a Black female, and you're really smart Ja'Netta. So they think of it as a compliment but in their head they think I'm going to get a job because of affirmative action or I'm going to get a job because some company wants to meet their quota of how many minorities they hire, which I know is a reality in this country but as hard as I worked I don't want you to feel like that's the reason why I'm getting accepted.

Although the women referred to their racial and gender status in reference to how other perceived their STEM academic ability, it appeared that their understanding of the

way others perceived their academic ability was more so about race than gender. When I asked the participants which social characteristic they felt marginalized them more, most often the response was race not gender which was described in the "fish out of water" subtheme. This was interesting finding considering that so many of the women participated in male-dominated majors.

Perceptions of Professors

All of the participants noted having a negative experience with a professor in college, which is the case with most college students. However, the participants who attended the PWI described experiences with professors regarding race. Several examples came up during the course of the interviews which suggested that the students in this study who attended the PWI did not feel as support by faculty and expressed differential treatment as a result of their race.

Ja'Netta often felt that she was forced to be the voice of all African American students. She felt that one of her professors made her speak up in class just to prove a point. Sasha never felt comfortable approaching the professor in her IT major. She expressed intimidation. She said that perhaps she would have felt more comfortable if her professor had been African American. Brittany talked about the assumptions she felt one of her professors made about African American people. He would constantly show up late to class and when asked why he said it was because the students were always late. He was slow to grade some of Brittany's work and when she questioned him about it he responded by saying he would give it to her the following week. Brittany felt that he assumed she was not concerned with her progress in his class because she was African

American and she got a sense that this professor felt his African American students were disinterested in learning. She sums up her feelings in the following passage.

> What bothers me is when I go to the professor and they're not open. I kinda wonder, like in the back of my head, is it because I'm Black or a minority that you're not talking to me, or this is just how the school operates, you know? I just want you to be more open and don't think just because I'm a chemistry major I know all of this. You know what I mean? I feel like there's a lot of assumption of what we should know or what we shouldn't know and they don't really realize that everybody learns differently. Everybody comes from a different background, and that to me is probably the HBCU versus predominately White institution.

Pam expressed a similar frustration with a professor. Upon receiving a poor grade in one of her college courses she scheduled a meeting with her professor. Pam arrived to the meeting prepared with her copy of the assignment along with the grading rubric. When she asked the professor for an explanation, the professor responded by saying she did not have the time to discuss the matter. When Pam asked for clarification, the professor called campus security. She reported Pam as an irate student in her office that would not leave. Pam recalled that her professor, a White female, was standing over her in a very dominating position. She later found out that the professor said she feared for her life and told campus security that Pam had threatened her. Here is what Pam had to say about the incidence.

> I can't be sure, I can't really say what you know her thinking was. I feel like her saying she you know feared for her life was a racial thing. I feel like if I was you know a White student she wouldn't have been scared or felt any type of way. I may have a strong personality but at the same time I know how to compose myself. I know how to act.

Again, the women perceived their interactions with professors to be fueled by race. There were not words used to denote that the professors were racist, but the participants were under the impression that their race was the reason the professors responded the way they did. Without taking anything away from the women in this study, I think it is possible that other experiences in the participants' lives may have contributed to how they perceived the actions of their professor. This interpretation is very telling in terms of how these women form their identities and view the world.

Lack of Cultural Responsiveness

Several of the participants in this study experienced racial microaggressions and contribute it to a lack of cultural responsiveness from individuals and institutional climates. Tanesha talked about the lack of cultural responsiveness she felt in her major courses. Tanesha felt that a lot of the things she experienced culturally growing up were not reflected in the college curricula. For example, in some of her classes she had to learn about cars. She described not being exposed to cars growing up and not having a father who worked on them. She felt all of her classmates talked about drag racing and were clueless as to why she didn't have a better understanding of the topic. She also talked about the comments other students or professors made about her name. She felt that she

was often stereotyped and that it made it more difficult for her to do well academically and get jobs or internships.

> I feel that sometimes and I have some people telling me it's beautiful and some people can't pronounce it. I feel sometimes when I send my resume out my name doesn't get me jobs. They can't pronounce it. They may not want to bring me in for an interview. Those are things that when I think about me in this field I'm like okay I know I have the capacity to be as successful as I want to be but I guess is this field going to allow me to be successful. Am I going to get the same opportunities as other people get because you know I'm black or because they can't say my name or because I'm a female. Those things you know like there were times when I was applying for internships back to back to back and I was getting no response you know I'm starting to think you know what's going on. My classmates are getting them. I don't know. You know I chalked it up to it was just my GPA but those are things I do keep in the back of my head.

Ja'Netta perhaps expressed demonstrating tolerance for her classmates more so than any other participant. She has a keen understanding of what she needs to do in order to be successful and sometimes for her that comes with exercising a great deal of patience while also learning to maneuver in challenging environments. When I asked about her perception of the lack of understanding her classmates display, she had this to say.

> I definitely study I feel like I shouldn't sacrifice academically because they don't know how to understand other cultures. I go out to social events but it's nothing like how I would with my friends like if we go out I'll

> probably have like one beer sit in there and not drink because I gotta be alert and watch what I say. I've never danced in front of any of them. When we go shopping I don't really look at the type of clothes I want to because what I would find attractive they'll probably be like that's club attire, that's ghetto. Me and a group of friends, it was a pretty cultural group, went to Books A Million. We went to every section and it was fine. Then I went to the African American section and was looking at different books and I swear to God they just disappeared and I was like we went to every single section but nobody felt comfortable enough to look at these books, ok.

To give me even more of an understanding of how aloof she perceived her classmates to be in regards to other culture she described the following experiences.

> Some of us worked with the ASCE concrete canoe a couple of weeks ago. I was wearing some Timberlands and some guy was like "those are some nice Timberlands right there. Are them steel-toed?" I'm looking at him and I'm like "no they're not" and he was like "that's a sarcastic question." The stereotype is that Black people always wear Timberlands thinking that they're good enough to wear to work. When I answered seriously he was like "oh it was a joke." Then another White male that I associated with was sitting there and the guy was like "man I got concrete in my nails let me wipe it off with that Brillo pad" cause my hair is natural and I had it in a ponytail. I had to walk away because I didn't get anything out of it and I was like "ok I don't want to entertain this." The fact that they're like "I

> have Black friends or I understand the Black struggle" they think it's ok for them to say all these slurs ya know and they think just because they're not doing it in anger it's ok.

In this section the participants described very racially charged interactions with their peers in STEM. Carlone and Johnson (2007) say that women who experience these disrupted identities perceive that their behavior, or even just their appearance trigged racial, ethnic or gender recognition that overwhelmed their chances of being recognized as good STEM students.

Gender

Throughout the study respondents indentified issues of gender. I found it very difficult to distinguish gender from race since the women in this study experience these social labels simultaneously. I concluded that the women in this study often talked about race and gender by placing one above the other. Usually, race was viewed by the participants as the most significant contributor to their minority status, yet there were some examples where gender was prioritized over race. The experiences below speak to the way the women in this study experienced their gendered status in their STEM majors.

OPPORTUNITIES. A few of the women commented on the lack of opportunities they experienced due to their gender status. Tanesha expressed concern about securing a job as a mechanical engineer in technology when she finished because of the physical demands of the profession.

> There's a lot of jobs out there for METs but you know I'm going to be a female in there with my hardhat on and my steel toed boots and maybe look crazy you know as opposed to a man in there. So, with this particular

> field yeah I do feel like it's different just for that fact. In my machine shop practices I can't even reach the machine sometimes when I have to change the bolt you know. So, you know I think about that and what if I get a job that I really can't do what's required physically but I think that's also something that I would want to look into before deciding on any job, you know, what exactly is going to be required of me.

Similarly, Brittany voiced concern about obtaining assistantships in science labs. Here is what she had to say about her experience.

> I've met a lot of professors who just prefer to have men work in their labs. Like, when I first got my job at Stone City, I had a professor who told me like, you know, females just get too emotional when something doesn't work out. When I give them a chemical process to follow and it doesn't follow through the way they want. They can get too emotional and they have too much going on so I don't hire them.

Lauren also had professors that displayed preferential treatment toward male students. When I asked her to describe the experience she responded with the following.

> I've had some teachers who I felt were kind of biased to their male students. They kind of like asked the females like "what are you doing here you know, why are you talking, are you really asking a question?" We don't even have a female Chemical Engineering professor in our department. We only have men in our department and there were at least two of them who I would say behaved in that manner. I feel like their behavior limits our opportunities.

SEXISM. When women participate in male-dominated fields there are often times when women feel overtly sexualized or objectified. Sasha talked about the discouragement she experience sometimes being in such a male dominated field. She actually referred to information technology as a sexist major. Tanesha experienced similar acts of sexism while seeking out internships. She described an experience she had with an African American male who worked for an engineering firm and a White male supervisor.

> Malcolm comes and he says well after you finish interviewing with her I want to ask her some questions. So, I'm like okay. You know I'm thinking I may get an internship. It wasn't anything to do with the job or whatever it was more along the lines of "how have you been in the year since I've seen you." It was a lot of questions that I didn't really understand and still at that time I didn't feel uncomfortable. We leave Pittsburgh and maybe two months later he starts texting my phone. "How are you doing? You know I've been thinking about you" and you know I'm flabbergasted like what. And I still at this point I don't feel uncomfortable, I'm just confused. I'm like so is he really just asking how I'm doing because he's trying to get me the job like he is just that helpful. I still never got the job. He tried to make it up to me by saying well whatever you need let me know and he starts trying to send me money and it ended up being a whole big deal. It scared me. It scared me because I said I don't want to have to deal with this. That's not my first time I feel like I've been sexualized. I did a job on campus and I felt the same way where I felt my supervisor was

> inappropriate sometimes. He was white so. It scared me because being in a male-dominant field as woman. It's a funny feeling…a funny feeling.

Ja'Netta also discussed feeling uncomfortable with an encountered with an African American male professor.

> I took this one class here and there's not a lot of African American males teaching in the Engineering department and this guy was from Africa and he talked about how he's so amazed that there's a Black female in Engineering and he wants me to be great. He said whenever I graduate he wants to take me to the UN and he wants me to make something of myself. He was just being overly being nice to the point where he was trying to invite me to social events and stuff, invite me to social medias and stuff and I'm like I'm not comfortable with this ya know.

It was very disheartening to hear some of the things these women experiences because of their gender. I think at times it even surprised them how they were treated as women. However, most of the women concluded that differential treatment or sexism was something they would have to accept and learn how to work around, especially for those women in male-dominated STEM fields.

Summary

This chapter presented the findings from this phenomological study. Participants' experiences were categorized into five themes (independence; support; pressure to succeed; adaptations; and race and gender) which were then broken down into subthemes. The organization of this chapter was best thought to respond to the research questions while portraying the stories of the participants as they experienced them.

Chapter five provides a more detailed analysis of these findings and how they relate to the current literature on African American women in STEM.

CHAPTER 5: DISCUSSION OF RESEARCH FINDINGS AND CONCLUSIONS

"Our silence has been long and deep. In canonical literature, we have always been spoken for. Or we have been spoken to. Or we have appeared as jokes or as flat figures suggesting sensuality. Today we are taking back the narrative, telling our own story."

--(Morrison, 2000, p. xii)

The historical experiences of African American women's oppression are thought to be structured along three interdependent dimensions: economy, polity, and ideology. Together, they operate as highly effective systems of social control designed to apportion African American women to subordinate ranks in society. The exploitation of African American women's labor, the denial of inalienable rights, and the use of negative stereotypes have all been fundamental to the oppression of African American women (Collins, 2000).

The history of African American women has been marked by many successes and failures. Particularly, educational institutions have fostered patterns of disenfranchisement over the years that have subjugated the academic experiences of African American women. Despite the challenges, conditions in the wider political and social economy have simultaneously shaped African American women's subordination while fostering activism. As a result, African American women have challenged their social positions in ways that have garnered success across all academic disciplines (Collins, 2000).

The historical struggle Collins (2000) describes above continues day. This dissertation study explored the factors that have influenced the academic success of African American women in the area of STEM, notwithstanding the challenges this group has faced historically. The struggles African American women have encountered over the years in their pursuit of educational attainment remain salient in the current literature. Particularly in the area of science, technology, engineering, and mathematics (STEM), African American women continue to face similar political, economic, and social barriers to success.

To examine the experiences of African American female STEM majors across the 16 public universities in the North Carolina system, I designed a phenomenological study using critical race feminism as the theoretical framework. I selected African American women in STEM because this particular subgroup of women reflects a unique set of problems within the education system. As an African American woman who majored in STEM, I have heard the informal stories of many other African American females about their experiences pursuing a STEM degree. I began to notice patterns of exclusion, resiliency, formation of identity, race, and gender across the stories and it made me wonder if there was anything to it…in other words, was this the typical experience for an African American woman in STEM? Listening to the interviews of the women who participated in this study reminded me of how difficult it was to pursue a STEM degree. Aside from our marginalized status, the content of STEM courses alone was a feat of undertaking for any college student. However, I found that the ways in which the women in this study experienced their marginalized gender and racial status simultaneously

produced outcomes for the participants that were similar, but also very unique to each individual.

A phenomenological approach using critical race feminism as the lens has helped to move the these experiences to the forefront of the discourse on African American women in STEM. I struggle to find patterns across this study. The only conclusion I can be certain of is that these participants' pursuit of a STEM degree was impacted by their marginalized racial and gender status. This dynamic shaped the way they identify as STEM majors and how the interact with and learn from family. The women who were conscious of their science identity constructions and oriented themselves in family were able to persist in their STEM majors.

So Now What?

Summarizing the experiences of the participants in this study has perhaps been the most difficult part thus far. My findings provide a view into the dissonance that constitutes so much of higher education STEM programs. It is a view that attempts to reposition the perspective of African American women in STEM; attempts to grasp the dimensions of the contradiction between being female in male-dominated fields and African American in majority White disciplines; and attempts to validate the structures and support networks which influence the participants in this study. This is a dissertation that engages with the journey of becoming an African American female STEM degree recipient. The findings help tell a story.

It is important to remain conscious that this dissertation is just that, a story. It does not reflect the experiences of all African American women who major in STEM. It is the story of 10 students. The topic is a common one, I suppose: the experience of pursuing a

STEM degree. The obvious connection to this work would be from other women and minorities and I suppose anyone who has completed a degree in STEM. This dissertation does not assert that pursuing a degree in STEM is any less difficult for other subgroups of students; it suggests that the individual experiences differ because of the way each person experiences their gender and race identities within STEM majors. For whenever I tell a fellow STEM major about my topic, I receive a nod of recognition. The journey is a difficult one. If it were easy, everyone would do it. I acknowledge and accept that. However, these participants' experiences provide a window into a system which is complex yet static.

Bracketing my own thoughts and beliefs through the analysis of my findings has been quite difficult. Hearing the participants explain their frustrations brought back memories from my own experience as an African American female STEM major. The stories also heightened my sense of frustration while trying to make sense of the complexity that surrounded these women and their experiences. Anytime I read a quote I could relate to I stopped and wrote down my feelings about it in a journal. Therefore, as I began to discuss and interpret the findings in this chapter, I found it was easier because I was not inserting my own subjectivity. While I cannot guarantee that pieces of me are not inserted in this study, I attempted to preclude as much of my own bias as possible. Having a fellow qualitative researcher look over my findings and interpretations helped me do this.

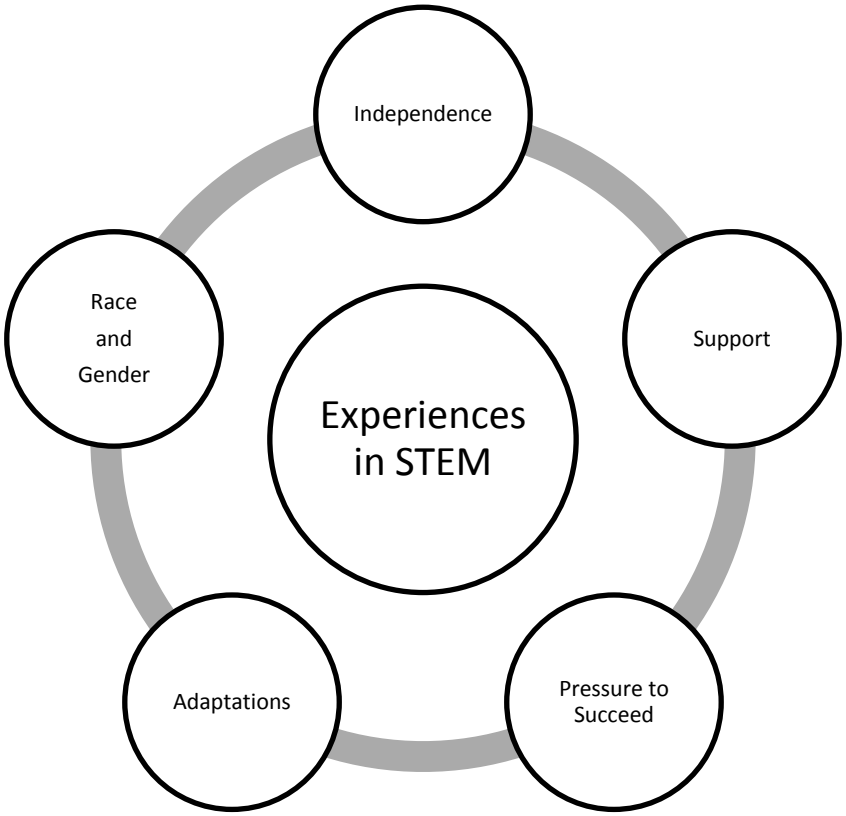

Figure 5.1: Themes from the study

Figure 5.1 is a visual representation of how all of the themes that emerged in this study surround and shape the experiences of the participants. The circle that threads through the themes suggests a connectedness so that the themes are not independent of each other, rather they work together to produce individual outcomes or experiences for each participant. I did specifically group the independence, support, and pressure to succeed themes together because they tend to reflect connections to family which was a topic that guided this study.

Independence

All of the women in this study talked about being independent to some degree. If anything else, the rigor of their degree required them to be. However, I found that for many of the participants, they learned independence at a very early age. Typically independence was produced in relation to the roles they assumed within their families. It was almost as if independence became as a survival skill for some of the participants. Brittany described working as a personal care assistant to bring in additional income and take care of her sick mother. Tanesha and Pam talked about having to become more independent because their parents were not always engaged. The hardships some of these women experienced and how they responded to these experiences, I believe, carried over into how these women participated in their STEM majors. It is also important to consider the women who did not learn independence through negligence or sacrifice, but as a responsibility passed down from one generation to the next. Hrabowski et al. (2002) describes how independence is encouraged among African American females in African American families. Having to be strong and self-sufficient appeared to be a characteristic most of the women in this study could relate to. In fact, their stories were often reflected as such.

Hrabowski et al. (2002) found that African American females are reared to be much more independent and resourceful than boys. They are often encouraged to be strong, self-sufficient, willing to stand up for themselves, and to fight back if necessary. At the same time they are taught to be nurturing and to be capable of taking care of children. Also, the female relatives in their lives often work to prepare them to handle the realities of discrimination and then be prepared to fend for themselves economically. The

findings from this study are consistent with prior research (Hrabowski et al., 2002). The findings of this research suggest that the strengths of African American families are much more influential that their weaknesses. Regardless of how the women in this study learned to become independent, this characteristic was reinforced by their family and it has appeared to serve them well in their pursuit of a STEM major. The important message is that how families parent and support differs by race, gender, and SES. Although the manner in which some of these women learned independence may not align with societal norms, their families were very influential in helping the women become STEM majors.

Support

Support was not in and of itself a very profound finding in this study. It can be assumed that most students who attend college receive some form of support from family, community, organizations, and peers. However, the findings from this study support the literature on African American families as productive contributors to academic success (Hanson, 2009; Hrabowskil, 2002). This finding is important because it challenges the deficit perspective in family studies literature; a considerable amount of family studies literature centered on African American families and culture is structured around low income families, single parents, health problems, substance abuse, violence, and welfare dependence (Few, 2007; Franklin, 2007; Tamis-LeMonda, Briggs, McClowry, & Snow, 2008). The findings from this study seem to challenge the aforementioned labels. While many of the women come from single-parent, low-income homes, their families act in ways that allow the participants to leverage their support as a mechanism to foster academic success in STEM.

Hanson and Palmer-Johnson (2000) note that African American subcultures provide young women with a unique set of resources that they can utilize in generating success in STEM. Guiffrida (2005) studied the support that African American families offer to their children. He found that students most often received support in the form of money, spiritual advice, academic guidance, and emotional support. I found similar themes among my respondents. The literature also acknowledges that different types of support function to encourage and motivate students to succeed academically. After identifying the types of support that participants received from family, friends, communities, and organizations, Guiffrida (2005) concluded that support functioned as a positive influence on students' academic success.

Financial

Essien-Wood (2009) conducted a similar study to this dissertation study that qualitatively explored factors that influenced the experiences of African American females in STEM. She found that monetary support from family was positively associated with participants' experiences. When family or community members are able to provide monetary support, it lessens the financial burden of the students. Most of the participants in this study held jobs, but Essien-Wood's (2009) findings suggest that financial support from family decreases the time participants spend working and increases the time they can set aside to study. Tracy and Lauren spoke about the financial assistance they received from their supporters. Lauren spoke very positively about the help she received from her church members while Tracy explained how getting financial help from her relatively absent father was quite difficult even though he was able to contribute at times.

Spiritual

Research suggests that African American families consistently demonstrate high levels of religiosity as compared to other families (Chatters, Taylor, Jackson & Lincoln, 2008). Brooks (2011) found that for African American families the church provides strength during challenging times, a support system, leadership opportunities, and religious traditions that have been passed down over many generations. Both Nicole and Lauren spoke positively about the spiritual support they received from church members and organizations. Nicole even made the connection between the spiritual support she received and her academic performance in STEM. They both consider the spiritual support they received as positively influencing their undergraduate experiences in STEM.

Academic

Research concludes that students who receive academic support from their families, communities, and organizations are more likely to demonstrate academic success (Hanson, 2009; Hrabowski, 2002). Hanson (2009) used parents' educational backgrounds as a measure of socioeconomic status. She found that differences in parents' education resulted in different science outcomes by race for the female STEM students. Overall, the students who had parents (and other family members) with higher levels of education and engagement tended to be more likely to do well in STEM. Furthermore, students who come from backgrounds where their parents and/or siblings have received college degree or college degrees in STEM are more likely to persist in challenging academic settings (Hanson, 2009).

Academic support was demonstrated as both a positive and negative form of support for the participants in this study. Bridget and Sasha talked about the positive

academic support they received from family members. Whether it was assistance with homework or help deciding upon a college major, both participants felt that their families positively contributed to their success in STEM. The findings for positive academic support do not completely support Hanson's (2009) findings of parents' educational background as a measure of academic success in STEM. Both Bridget and Sasha came from two-parent households and between the two of them only one parent received any type of college degree. Perhaps on a parent education continuum, Bridget and Sasha would have been less likely to persist in STEM had their parents not graduated from high school.

Brittany, Nicole, and Tracy all referenced times when they did not feel academically supported by their families. Nicole and Tracy had family members who had graduated from college, however, Brittany would be the first in her family to do so. In the examples where these women did not feel academically supported, it appeared to be less connected to their parents' educational backgrounds and more associated with the participants' STEM discipline. Although Nicole had other family members who received degrees in STEM, they could not relate to her specific discipline leaving her feeling unsupported. The degree to which parents' educational backgrounds influence the participants' success in STEM is rather ambiguous. However, the women who did not feel supported academically, felt that way because their family members could not relate to the content within their specific STEM disciplines.

Encouragement and Motivation

The types of support participants received or did not receive from their families functioned as encouragement and motivation for these women to persist in their STEM

majors. Brooks (2011) found that encouragement from family members positively influenced that success of African American college students. The examples given by Tanesha and Bridget support the findings in the existing literature. Encouragement was most commonly displayed through kind words and gestures. Essien-Wood (2009) cited motivation to as a factor that supported the success of the African American female STEM majors in her study. She found intrinsic forms of motivation to be more relevant to the participants in her study, yet the participants in this dissertation study utilized more extrinsic forms of motivation. Pam and Tanesha were motivated to do well so that they could take care of younger siblings while Tanesha received her motivation from supportive friends. Tanesha was also motivated by the fact that she would be the first in her family to receive a STEM degree.

The experiences of the participants in this study contribute to the literature that recognizes African American families as a supportive mechanism of African American female STEM students' academic success. Utilizing a critical race feminist framework positions this study to highlight these positive assertions of minority families. These findings challenge and help to redefine the existing literature that labels African American families as low income, single-parent, sickly, substance abusive, violent, and welfare dependant

Pressure to Succeed

I believe the pressure to succeed in college is present for the general majority of students enrolled. Hanson (2009) suggests that this pressure for African American females is the result of the cultural and community capital these women receive from their families. Hanson (2009) also argues that the social capital African American

families possess can counter the lack of economic capital in poor families and communities (Warren et al., 2001). Putnam (2000) argues that social capital is used to increase social cohesion, resolve collective problems through individual organization for change, and increase the sharing of (and access to other) resources. The participants in this study reinforce quite often how their success in STEM would positively impact their families. African American families and communities are making particular investments in African American females due to their increased enrollment in college (Hanson, 2009). Hanson (2009) states that African American families and communities provide a type of social capital that contributes to African American female's success in STEM. Thus, African American females feel an obligation to succeed and give back to the family and community that has supported them.

The participant's experiences in this study support Hanson's (2009) findings. Not all of the participant's families in this study are poor, but there are several women who feel a pressure to succeed so that they can financially contribute to their families. Tanesha spoke about buying a house for her grandmother and Brittany and Pam talked about assisting younger siblings through college. Tracy felt pressure because she would be the first in her family to receive a degree that would allow her become a doctor. No matter the reason, the pressure was present for all of the participants in this study and they used it as a means to fuel themselves forward in their pursuit of a STEM degree.

Perhaps it is true that the majority of STEM majors, or college students for that matter, feel pressure to do well academically. In fact, many students may feel an obligation to give back to their families and communities. However, the tenets of critical race feminism suggest that how African American women experience this pressure in

STEM and how they utilize support from their families differs from males and White women due to their marginalized racial, gender, and socioeconomic status (Evans-Winters & Esposito, 2010). Therefore, it can be assumed that family dynamics between African American females and their families also differs from males and White women. The cohesiveness that Hanson (2009) describes when talking about African American females and their families challenges racist historical assumptions associated with African American families while simultaneously providing evidence that minority families foster positive academic experiences in STEM for African American females.

Adaptations

Adaptations were a particularly important finding in this study. The participants spoke about having to develop certain personality characteristics in order to acclimatize to their STEM academic environments. There appeared to be a constant struggle between how they identified as African American females and how they identified as African American female STEM majors. The STEM identities these women have formed and continue to mold are reflective of their race and gender. Carlone and Johnson's (2007) model of science identity was an effective framework for analyzing the experiences of the participants in this study. It is especially helpful because of the overlap between the tenets in this dissertation's theoretical framework (critical race feminism) and the constructs of the science identity model. Both frameworks "focus on the lives of women of color who face multiple forms of discrimination due to the intersections of race, class, and gender within a system of White male patriarchy and racist oppression" (Evans-Winters & Esposito, 2010, p. 20). Considering the historical implications of patriarchy in STEM-related disciplines, the findings from Carlone and Johnson (2007) were essential

to the analysis of the participants' science identities through a critical race feminist lens. The science identity model reflected the following three categories: research, altruistic, and disrupted. I attempted to classify the participants in this study based on the aforementioned categories.

Several of the women in this studied were affected by what Carlone and Johnson (2007) refer to as a disrupted identity. The label of "disrupted science identity" explains how women of color experience some form of dissatisfaction with how they are positioned in STEM and feel that their pursuit of their degrees had been disrupted. This did not mean these women are unable to create science identities, rather they focus on experiences where they felt overlooked, neglected, or discriminated against by "meaningful others" within science. I think to some degree all of the women could relate to an experience where they felt that their pursuit of a STEM degree had been disrupted. Nevertheless, the participants in this study who fell into this category tended to display more feelings of doubt. While all of the women experience barriers they had to overcome, Angel and Tanesha talked about having their STEM experiences disrupted because of poor grades. Instead of acknowledging their status as a scientist or engineer, the stories of these two participants tended to focus on times when they felt overlooked as scientists because of poor academic performance. Despite the rough academic start, the women were able to persist in their degree programs and form identities as STEM majors.

Lauren displays what Carlone and Johnson (2007) refer to as an altruistic science identity. She was able to create her own definition of science, redefine whose recognition mattered to her, and in some cases, redefine what it means to be a woman of color in

science. She talked about not feeling intimidated in her STEM courses just because someone else may perform better than her. Lauren was able to engage in successful cultural productions. Carlone and Johnson (2007) suggest that these cultural productions enable the development of strong, redefined science identities. Lauren found strength in her spirituality, which she considered more of a defining factor of her science identity than those around her. Women who identify with this category sometimes struggle with low competence; they don't always believe in their academic ability. Tanesha displays signs of low competence. She talked about having to change her identity to adapt to the academic environment in her STEM courses where she did not always feel validated academically. Her quote was an examples of a pep talk she often gave herself to be reminded that she could shape her own identity in a way that allowed her to experience success in her major.

Even though her STEM peers were not always confident in her academic abilities, Pam was always confident in her potential. In chapter four she makes a reference to herself as being a STEM major. According to the science identity model, women who identify themselves as scientists are categorized as having a research identity. Pam saw science in a very exciting way and she knew she was capable of doing the work. She talked about having to asset herself and display self-confidence when her STEM classmates took too much of the lead on group projects. In this moment Pam challenged essentialist views of what it means to be an African American women majoring in STEM by proclaiming her status as a STEM major. Regardless of the science identity that participants related to, each individual was able to leverage her science identity in a ways that produced positive outcomes in her STEM trajectory.

Race and Gender

Race and gender permeated the findings of this study. Hanson describes the intersection of race and gender as the double jeopardy argument which "assumes an additive effect of the two statuses—being female and African American" (Hanson, 2007, p. 8). The "double bind" of being a minority female in STEM functions simultaneously to produce distinct experiences for women of color in STEM. Theoretical discussions of climate—often described as "chilly"—address evidence that women receive differential treatment when compared to men, from science faculty and peers (Justin-Johnson, 2004). Yet the inclusion of racial and ethnic discrimination presents an ever more complicated environment for women of color. Several studies specifically demonstrated the gender *and* racial/ethnic bias that women of color experience on a day-to-day basis as STEM majors, situating them in a unique position of confronting multiple systems of oppression (Carlone & Johnson, 2007; Justin-Johnson, 2004; Ong, 2002; Sosnowski, 2002; Valenzuela, 2006).

The examination of this particular subgroup of women began because of their marginalized racial and gender status. While I expected that all of the women would acknowledge their race and gender to some degree, I was not completely sure how each woman would experience her status in relation to her STEM major. What I found is that the women who attended the PWI experienced feelings of isolation and a lack of cultural responsiveness more so than the participants who attended the HBCU. It is also important to note that the race and gender theme was the only theme that had a distinct separation between the types of institution participants attended. My findings support previous studies' (Johnson, 2007; Justin-Johnson, 2004) findings which suggest that HBCUs

provide educational experiences for African American women in STEM that are culturally reaffirming and positive. I do not presume to suggest that PWIs do not provide opportunities to African American women, but based on the participants in this study, those who attended the PWI did not feel included. Obviously, this conclusion is limited to this study. The women in this study also acknowledge their race as a more significant source of oppression they experience than their gender. I found this to be surprising considering the number of participants in male-dominated majors. While gender was pervasive throughout the findings, it was typically considered as an afterthought to race. I believe this has several implications for how colleges and universities structure their STEM programs.

A Fish out of Water

Several of the women expressed feeling excluded at times in their STEM majors. All of the women who attended the PWI referenced feeling like they "stuck out like a sore thumb." Ong (2005) describes this exclusion as participants not feeling a sense of belonging. The nature of STEM environments that are centered on Whiteness and maleness contribute to the difficulty women of color to feel included in their academic environments. Negative interactions with male peers and faculty, isolation from racial/ethnic group peers, negative racial climate perceptions, encounters with negative racial and gender stereotypes, and lost confidence all contributed to a lack of belonging experienced by women of color in STEM. While individual-level characteristics are indeed important to the attraction, retention, persistence, and ultimate educational attainment of minority women in STEM fields, the varying degree of success that minority women in STEM realize by institutional type and whether they are enrolled in

minority-serving colleges or universities suggest that institutions and their cultures, climate, policies, and practices also matter (Chang, Cerna, Han, & Saenz, 2008; NSF, 2009; Solórzano, 1995; Wolf-Wendel, 1998). Justin-Johnson (2004) refers to this exclusion as racial isolation which he found to be prevalent among the African American female STEM majors in his study who attended PWIs.

STEM Intellect

Some of the women who attended the PWI discussed feeling like their academic ability in STEM was questioned by their peers and professors. Essien-Wood describes this phenomenon as an "ascription of intelligence." She says this occurs when minority students are underestimated based on their intelligence not their ability. Instances of "ascription of intelligence" were described by Sasha and Tanesha. Sasha talked about not having her STEM intelligence valued because her classmates would give her what they considered to be the least difficult part of group projects. Tanesha explained conversations she had with classmates where she felt they insinuated that she would get a job because she was an African American female, not because she was really smart.

Perceptions of Professors

Several of the participants talked about a negative experience they had with a professor. However, the students who attended the PWI seemed to have more racially charged interaction with faculty members. Faculty involvement has been cited in the literature as a positive influence for college students seeking STEM degrees (Mitchell, 2011). There is evidence to suggest that students who attend HBCUs and major in STEM often feel better supported in their academic environments, which includes relationships with professors (Johnson, 2007; Justin-Johnson, 2004). This is not a monolithic argument

because minority students receive faculty support at PWIs as well, yet the literature seems to suggest that the academic climate in PWIs is less likely to be accommodating to minority students (Johnson, 2007; Justin-Johnson, 2004).

Lack of Cultural Responsiveness

The women who attended the PWI often felt a lack of cultural responsiveness in their STEM degree programs. The women talked about the environments in their classrooms and how they did not always feel reflected in the curriculum or classroom conversations. Similar findings have been reported in the literature about minority STEM students, especially at PWIs (Johnson, 2007; Justin-Johnson, 2004). The findings from Ong et al.'s (2011) study suggest the need to address STEM pedagogy and curriculum for diverse populations as well as research on the relationship between pedagogical changes and cognitive outcomes for women of color (Ong et al., 2011). Recruitment and retention of African American women in STEM is contingent upon creating an environment where the students feel reflected in the environment and the course curricula.

Opportunities and Sexism

The culture of STEM departments and organizations is an important consideration, in that they include a structure that is supposedly meritocratic in nature and focused on grades, classroom performance, and research results. The culture nevertheless ignores the social realities of racism and sexism in science environments (Carlone & Johnson, 2007; Varma, 2002). The differences in gender were not a clear cut as race in regards to institutional type. The women at both the HBCU and PWI were aware of and negatively experienced their marginalized gender status. The women in this study felt the most significant impact of their gender when they were seeking employment

opportunities in STEM or in their interactions with men in power. Brittany and Lauren both perceived their professors to give preferential treatment to the males in their classes and labs.

The race and gender theme is a connective piece in this dissertation study, and it is an essential component of critical race feminism. Not only has the participants' racial and gender status contributed to the formation of their science identity, but it also reflects ties to and relationships with family. The experiences described in this section "assert the multiple identities of consciousness" of the participants (Evans-Winters & Esposito, 2010, p. 20).

Recommendations and Areas for Future Research

My first set of recommendations is geared toward the climate of institutions serving African American female students in STEM. Many females graduate from high school with the academic preparation to pursue a STEM degree, but few of them major in science or engineering. Changes can be made to the culture in college and university STEM departments such as revising admission requirements, reorganizing introductory STEM courses to adapt the learning styles of students and providing a student lounge or area in the department where students can study. Similarly, colleges and universities must hire more science and engineering female faculty of color if they wish to improve the integration of female students and faculty into the departmental culture. A presence of more women and women of color in STEM departments across campuses could assist in improving recruitment and retention rates for women of color. African American would should be involved with STEM faculty at every staged of their undergraduate career. STEM faculty are essential to creating a positive campus racial climate because they are

more likely to make special efforts to involve women of color in research, networking opportunities, and jobs/internships. Faculty need to become more open and willing to discuss important issues of race and gender in courses, learn about the specific issues facing women of color in STEM, and examine their own biases about who is capable of doing science.

Several of the women in the study who attended the PWI cited racial discrimination as a barrier they had to overcome. PWIs could take a note out of the book of HBCUs by looking at their recruiting, retaining, and graduating initiatives. Reviewing the historical significance of HBCUs and the strategies these institutions employ could be very useful in changing the diversity policies at PWIs. Providing academic and social support programs to assist with navigating upper level courses and encourage faculty-student interaction could also be useful. It is necessary to offer academic support services, peer mentoring and tutoring, and affinity groups in the residence halls for students who share similar interests. This can be provided by academic affairs department or it can be house in individual STEM departments. Prior research (Johnson, 2001; Ong, 2005; Sosnowski, 2002) suggests that faculty interactions positively influence the confidence of women in STEM. The perceptions of faculty presented in the current study should be troubling to STEM educators and encourage them to generate opportunities for both formal and informal interactions with the female students in their departments even in their freshman year of college. Many of the participants in this study talked about the financial support they needed to persist in their majors. PWIs could provide additional funding to African American females who need to work to stay in school even though it may take away from their study time.

Given that the culture of STEM is identified with and centered on White and to some extent, Asian men, change must occur by challenging and transforming the dominant ideology in STEM. Based on the results of the current study, the participants spoke about the isolation their experience because of their racial and gender status. Providing a curriculum that is more culturally affirming for African Americans could assist in helping them better understand the concepts and maintain interest in their majors.

My second recommendation is geared toward what universities and colleges can do to leverage the support of family and communities. The findings from this research suggest that minority families play a huge role in the persistence of African American females in STEM. It is important that colleges and universities be aware of the demands and responsibilities require of African American females in relation to their families. Creating programs to ease the transition into college and STEM programs as African American women leave their families could be very help. Providing organizations that create a sense of family could be reaffirming for students. Several of the participants made reference to organizations like NESBE which they feel helped them persist in STEM.

Essien-Wood (2009) appropriately framed how the recommendations of this study attempt to alter the discourse surrounding African American women in STEM. She states that “these recommendations attempt to focus the direction of change on individual women in STEM by helping them adapt to the existing STEM culture as a way to succeed in an academic system in which they are not privileged members. Indeed, proponents of integration as the path to the successful retention of college students might

agree with this tactic. However, to achieve lasting effects, change must be directed toward the institutional structures and dominant cultures that perpetuate African American women's underrepresentation in STEM fields. As higher education institutions continue to enroll students that are diverse in race, ethnicity, gender, language, sexual identity, ability status, and social class (El-Khawas, 2003), research on STEM educational experiences and outcomes can use college impact theories to identify the structures that privilege some students in STEM, and incorporate a transformative perspective to dismantle and transform these structures so that all students can fully participate in STEM fields" (Essien-Wood, 2009, p. 149).

Given the lack of literature on African American females in STEM, it is vital that future studies also examine this particular subgroup. This study has focused on illuminating the experience of African American females in STEM. This area of research requires additional investigation because too little remains known about this population. This study used the framework of critical race feminism; however future studies could utilize other forms critical theoretical frameworks that also may provide valuable insights into the phenomena being studied. Future studies may consider extending the number of institutions from which they select participants. This would increase the trustworthiness of the data. Future research should also utilize a qualitative methodological framework so that the voices of African American women in STEM continue to be heard. Future research on this topic should be qualitative in nature, which will allow the often unheard voices of African American women to be given a platform to voice their experiences. The use of interviews, focus groups, and classroom observations would be an effective method for data collection. In addition, future studies should consider examining the

interactions between faculty members and African American female STEM majors, which would provide a greater understanding of the dynamics between these groups. I also think it would be beneficial to study other subgroups of women and men who encounter similar issues in STEM.

Limitations of the Study

As with all research, this dissertation study suffered from several limitations. Limitations to this dissertation study included only using one method to collect data from participants, the semi-structured interview. Although a semi-structured interview of a participants' lived experience is often a source of rich data, it did allow for other forms of communication to express the experiences African American females in STEM within the context of the familial characteristics. It is possible that the interview protocol utilized in this study may have also limited the findings. The protocol was designed for the NSF study described in chapter three, therefore all of the questions in the protocol were not tailored to the specific inquiry of this dissertation study.

The selective nature of this research study also limits the findings. The interviewees themselves were selected from a pool of several hundred individuals to fit the criteria for this study and the use of only two institutions also limits the scope of this study's findings. This study does not address other subgroups of people by race and gender nor does it include diversity in the geographic location or size of institutions.

The fact that this dissertation study was a qualitative investigation eliminates the generalizabilty of future findings, as it the case with all qualitative research. The findings from this study may not be applicable beyond the research sites, especially given the limited population from which to interview. While general applicability is not necessarily

the goal of qualitative research, it is a limitation to consider when reviewing the findings in other postsecondary contexts.

Conclusions

In reflecting upon Morrison's (2000) quote which opens this chapter, I become a bit nostalgic. It was the intention of this dissertation to tell the stories of very complex women who are persisting in fields from which they have been historically excluded. Their stories have not been fairy tales. Some of them have lived difficult lives and experienced things people should never have to. Today, though, their stories mean something. They are not tainted by the biased views of the literature, they reflect the truth; the participants' truth. This study may not change the course of action in STEM education because it lacks generalizability and numbers. However, it represents a small piece of the puzzle and it strives to continue to change the narrative about African American women in STEM. African American girls are scientists too.

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APPENDIX A: NSF STUDY SCREENING SURVEY

1. Welcome to "Finding the Roots," a survey that examines some of the reasons college students choose their academic majors. Before taking part in this study please read the consent form below and click the "I agree" button at the bottom of the page if you understand the statements and freely consent to participate in the study.

Consent Form

This study involves a survey designed to screen for future online interviews. Completing the survey typically takes 10 minutes and responses are strictly confidential. Participants begin by answering a series of survey questions about themselves and their academic experiences.

All responses are treated as confidential and your responses will not be linked to your identity. You are being asked to provide your email addresses if you are interested in participating in an hour-long interview regarding these issues. Be aware that confidentiality will be maintained to the extent possible. There is always the risk of compromising privacy, confidentiality and/or anonymity when using email and the internet. However, the risk to your physical, emotional, social, professional, or financial well-being is considered to be less than minimal.

There are potential direct benefits to you as a result of participation. If you complete the survey within the first 24 hours it is sent out, you will be entered into a drawing for a $150 Amazon gift card. In addition, if you complete the survey within the first 48 hours it is sent out, you will be entered into a drawing for a $100 Amazon gift card. Finally, if you complete the survey within the first 72 hours it is sent out, you will

be entered into a drawing for a $50 Amazon gift card. If you are selected for an interview and complete that interview, you will be paid $25 and entered into a drawing for a $100 Amazon gift card. We will be giving out one $100 gift card at your campus.

Participation is voluntary. Refusal to take part in the study involves no penalty or loss of benefits to which participants are otherwise entitled, and participants may withdraw from the study at any time without penalty or loss of benefits to which they are otherwise entitled.

If you have further questions or concerns about your rights as a participant in this study, contact the Compliance Office at (704) 687-1871. If you have questions concerning the study, contact the principal investigator, Professor Elizabeth Stearns at (704) 687-6250 or by email at elizabeth.stearns@uncc.edu.

You may print a copy of this form. If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, click "I agree" below to begin the survey.

Do you wish to continue?

- ☐ I agree
- ☐ I do not agree

2. [required] What's the name of the university where you are currently enrolled?
    a. Appalachian State University
    b. East Carolina University
    c. Elizabeth City State University
    d. Fayetteville State University
    e. Johnson C. Smith University {for pilot study only}

f. North Carolina A&T

g. North Carolina Central University

h. North Carolina School of the Arts

i. North Carolina State University

j. UNC-Asheville

k. UNC-Chapel Hill

l. UNC-Charlotte

m. UNC-Greensboro

n. UNC-Pembroke

o. UNC-Wilmington

p. Western Carolina University

q. Winston-Salem State University

3. [required] When do you expect to graduate?

    r. Spring 2013

    s. Summer 2013

    t. Fall 2013

    u. Spring 2014

    v. After spring 2014

4. [required] What is your major? {input list of majors}, plus other _____

5. [required] When did you first know that you wanted to major in this field?

    w. Elementary school

    x. Middle school

    y. High school

z. During college

aa. Don’t know

bb. Other _____

6. [required] Do you have a second major?
7. If yes, what is your second major?
8. [required] When did you first know that you wanted to major in this field?

cc. Elementary school

dd. Middle school

ee. High school

ff. During college

gg. Don’t know

hh. Other _____

9. [required] Do you have a third major?

ii. If yes, what is it?

10. {If answer to 5 is yes} Which of the following fields of study do you identify with most closely?

jj. Arts and humanities

kk. Social sciences

ll. Biological sciences

mm. Earth sciences, oceanic and atmospheric sciences

nn. Agricultural sciences

oo. Engineering

pp. Physical sciences

11. [required] When did you first know that you wanted to major in this field?

    qq. Elementary school

    rr. Middle school

    ss. High school

    tt. During college

    uu. Don't know

    vv. Other _____

12. Do you have a minor?

    ww. Yes

    xx. No

13. What is your minor?

14. {If answer to 5 is yes} Which of the following fields of study do you identify with most closely?

    yy. Arts and humanities

    zz. Social sciences

    aaa. Biological sciences

    bbb. Earth sciences, oceanic and atmospheric sciences

    ccc. Agricultural sciences

    ddd. Engineering

    eee. Physical sciences

15. {If answer to #7 is a-b} Did you ever consider majoring in a STEM field (science, technology, engineering, or mathematics)?

    fff. Yes

    ggg. No

16. {If answer to #7 is c-g} What were the top three reasons you chose a STEM field (science, technology, engineering, or mathematics)?

    hhh. A math/science course that really interested me.

    iii. A math/science teacher who was exceptional or who encouraged me to pursue a science major.

    jjj. A friend who was a STEM major.

    kkk. My parents or other family members encouraged me to pursue a STEM major.

    lll. It was suggested by a career counselor or career personality test

    mmm. I received funding/an award that prompted me to pursue a STEM major, please specify opportunity_____

    nnn. The job opportunities or salary

    ooo. I discovered that I have an aptitude for math/science

    ppp. Or was there some other reason why you chose a STEM major?, please specify, _____

17. Did you change your mind about your intended major after you started taking classes but before you officially declared a major?

18. If yes, what field did you originally intend to major in?

i. Arts and humanities
ii. Social sciences
iii. Biological sciences
iv. Earth sciences, oceanic and atmospheric sciences
v. Agricultural sciences
vi. Engineering
vii. Physical sciences
viii. Business/management
ix. Other _____

19. Did you change declared majors during your college career?

20. If yes, in what field was your first declared major?

x. Arts and humanities
xi. Social sciences
xii. Biological sciences
xiii. Earth sciences, oceanic and atmospheric sciences
xiv. Agricultural sciences
xv. Engineering
xvi. Physical sciences
xvii. Business/management
xviii. Other _____

21. [required] Have you attended more than one four-year college?

    qqq. Yes

    rrr. No

22. [required] Did you attend community college prior to starting at a four-year college?

    sss. Yes

    ttt. No

23. [required] Did you attend a math/science-focused high school or a high school with a math/science magnet program?

    uuu. No

    vvv. Yes, but I wasn't a part of the math/science program

    www. Yes, and I was part of math/science program

    xxx. Don't know

24. [required] Did you take the SAT when applying to college?

    yyy. Yes

    zzz. No

25. {If selected a in #15) What was your highest approximate score on the SAT math section?

    aaaa. Under 210

    bbbb. 210-300

    cccc. 310-400

    dddd. 410-500

    eeee. 510-600

ffff. 610-700

gggg. 710-800

26. {If selected a in #15} What was your highest approximate score on the SAT verbal section?

hhhh. Under 210

iiii. 210-300

jjjj. 310-400

kkkk. 410-500

llll. 510-600

mmmm. 610-700

nnnn. 710-800

27. Did you take the ACT when applying to college?

oooo. Yes

pppp. No

28. {If selected b in #15} What was your highest composite score on the ACT?

qqqq. 9 or lower

rrrr. 10-12

ssss. 13-15

tttt. 14-16

uuuu. 17-19

vvvv. 20-21

wwww. 22-24

xxxx. 25-27

yyyy. 28-30

zzzz. 31-33

aaaaa. 34-36

29. [required] What was your unweighted high school GPA?

bbbbb. <2.0

ccccc. 2.0→2.5

ddddd. 2.51→3.0

eeeee. 3.01→3.5

fffff. 3.51→4.0

ggggg. Above 4.0

30. [required] Where did you spend most of your high school career?

hhhhh. In North Carolina

i. If yes: What kind of high school did you attend? (1) public high school (2) private high school (3) home school

ii. Please specify the name of your high school here _____.

iiiii. Outside of NC, but within the US

jjjjj. Outside of the US

31. What kind of high school did you attend?

kkkkk. Public high school

lllll. Private high school

mmmmm. Home school

nnnnn. Please specify the name of your high school here_____

32. What is your sex?

ooooo. Male

ppppp. Female

33. How old are you?

qqqqq. Younger than 21

rrrrr. 21

sssss. 22

ttttt. 23

uuuuu. 24

vvvvv. 25

wwwww. 26-29

xxxxx. 30 or older

34. Which of the following categories applies to you? Choose all that apply.

yyyyy. American Indian/Native American

zzzzz. Asian-American/Pacific Islander

aaaaaa. Latino/a/Hispanic/Chicano/a

bbbbbb. African-American/Black

cccccc. White/European-American

dddddd. Other

35. Did you consider the degree of family friendly flexibility in your future career when deciding what major to choose?

eeeeee. Yes

ffffff. No

36. Do any of your family members have an academic degree in a science, technology, engineering, or mathematics field?

    gggggg. Yes

    hhhhhh. No

37. Do any of your family members work in the areas of science, technology, engineering, or mathematics?

    iiiiii. Yes

    jjjjjj. No

38. What is your marital status?

    kkkkkk. Single

    llllll. Long-term and/or co-habiting partnership

    mmmmmm. Married

39. How many hours do you work each week at a paid job?

    nnnnnn. 0-5

    oooooo. 6-10

    pppppp. 11-15

    qqqqqq. 20+

40. Do you currently or have you had an internship?

    rrrrrr. Yes

    ssssss. No

41. Do you receive need-based financial aid?

    tttttt. Yes

    uuuuuu. No

42. Did one or more of your parents attend college?

vvvvvv. Yes

wwwwww. No

xxxxxx. Don’t know

43. Did one or more of your parents graduate from college?

yyyyyy. Yes

zzzzzz. No

aaaaaaa. Don’t know

44. Where do you live currently?

bbbbbbb. On-campus

ccccccc. Off-campus with family

ddddddd. Off-campus alone or with roommates

45. Do you have any children?

eeeeeee. Yes, living with me

fffffff. Yes, not living with me

ggggggg. No

46. How do you plan to spend the year after college graduation?

hhhhhhh. Working

iiiiiii. In military service

jjjjjjj. As a stay-at-home parent

kkkkkkk. Graduate school in an academic field

lllllll. Graduate school for education

mmmmmmm. Graduate school for social work

nnnnnnn. Medical school

ooooooo. Law school

ppppppp. Veterinary school

qqqqqqq. Pharmacy school

rrrrrrr. Dental school

sssssss. Getting my MBA

ttttttt. Other type of professional school _____

uuuuuuu. Not sure yet

vvvvvvv. Other_____

47. Which of the following clubs/organizations have you been a member of during your college career? Please check all that apply.

wwwwwww. Sorority/fraternity

xxxxxxx. Religious club or association

yyyyyyy. Ethnic club

zzzzzzz. Community service club

aaaaaaaa. Student government

bbbbbbbb. School newspaper/magazine/yearbook

cccccccc. Intramural athletics

dddddddd. Intercollegiate athletics

eeeeeeee. Discipline-specific academic club

ffffffff. Music, drama, art, or poetry club

gggggggg. International-themed club

hhhhhhhh. Honors clubs/associations

48. [required] We are seeking participants to interview for approximately one hour to further explore how students choose college majors. We will pay you $25 upon completion of the interview, and you will also be entered into a drawing for other, larger monetary prizes. Are you interested in being interviewed?

    iiiiiiii. Yes

    jjjjjjjj. No

49. Name

50. Phone number

51. Email address

52. What would be your preferred technology for this interview?

    kkkkkkkk. Skype

    llllllll. Google Plus

    mmmmmmmm. Phone

    nnnnnnnn. In-person

    oooooooo. No preference

53. Are you also interested in having your name entered into a drawing for one of the Amazon gift cards for having completed this survey?

    pppppppp. Yes

    qqqqqqqq. No

APPENDIX B: SCREENING SURVEY PARTICIPANT SELECTION

Majors

- selected at STEM major for question 4 and/or;
- responded yes to question 6 and selected a STEM major for question 7 and/or;
- responded yes to question 9 and selected a STEM major for question 10

Leavers

- responded yes to question 17 and
- selected biological sciences; earth sciences, oceanic and atmospheric sciences; agricultural sciences; engineering; physical sciences; other (STEM major) for question 18 and
- selected a non-STEM major for question 4

Avoiders

- responded yes to question 13 and selected a non-STEM major for question 4 and/or;
- responded yes to question 15 and selected biological sciences; earth sciences, oceanic and atmospheric sciences; agricultural sciences; engineering; physical sciences; other (STEM major) for question 16 and selected a non-STEM major for question 4 and/or;
- responded yes, and I was part of math/science program for question 21 and selected a non-STEM major for question 4 and/or;
- responded between 610 and 700 or 710 or higher and selected a non-STEM major for question 4

APPENDIX C: RECRUITMENT SCRIPTS

Title: $25 for one-hour interview

Dear _____,

Thank you for responding to the screening survey from the Roots of STEM project. This is a National Science Foundation (NSF) funded project to learn more about influences on students' majors. We would like your input and request to interview you for approximately one hour regarding your academic history and choice of college major. Please respond by _____ (a date two days out) with a few good days and times over the next week for this interview, and we will coordinate our schedules for a {Skype, phone, or in-person} interview. Likewise, if you decline to participate, would you please let us know?

As a thank you for your time and participation, you will receive a check for $25 for completing this interview. The university needs you to fill out a vendor information form to process this payment. If you agree to an interview, I will send the form to you. Please fill out and return to me via e-mail or mail to the study's Principal Investigator (the mailing address is below).

If you agree to an interview, I will also send you the informed consent form. Please review it prior to the interview. I will ask you to give verbal consent at the beginning of our interview. If you have any questions about the study, you may ask me or contact Elizabeth Stearns, Principal Investigator (Elizabeth.stearns@uncc.edu).

Sincerely,

Mailing address for vendor information form:
Elizabeth Stearns
UNCC Department of Sociology
9201 University City Blvd.
Charlotte, NC 28223

Title: Follow-up for $25 one-hour interview

Dear _____,

Thank you for responding to the screening survey from the Roots of STEM project. This is a National Science Foundation (NSF) funded project to learn more about influences on students' majors. We would like your input and request to interview you for approximately one hour regarding your academic history and choice of college major. Please respond by _____ (a date two days out) with a few good days and times over the next week for this interview, and we will coordinate our schedules for a {Skype, phone, or in-person} interview. Likewise, if you decline to participate, would you please let us know?

As a thank you for your time and participation, you will receive a check for $25 for completing this interview. The university needs you to fill out a vendor information form to process this payment. If you agree to an interview, I will send the form to you. Please fill out and return to me via e-mail or mail to the study's Principal Investigator (the mailing address is below).

If you agree to an interview, I will also send you the informed consent form. Please review it prior to the interview. I will ask you to give verbal consent at the beginning of our interview.

If you have any questions about the study, you may contact Elizabeth Stearns, Principal Investigator (Elizabeth.stearns@uncc.edu).

Sincerely,

Mailing address for vendor information form:
Elizabeth Stearns
UNCC Department of Sociology
9201 University City Blvd.
Charlotte, NC 28223

APPENDIX D: INTERVIEW PROTOCOL

Warm-Up	• Thank you for agreeing to be interviewed by our team. • I am _____. {say a little about yourself, i.e. where you are working, what your role is student/faculty/ what field you are in, etc.) • Confirm the respondent's name. Tell them you won't use the name again in order to assure anonymity. • We are interested in the factors that influence how people choose their college majors. • Press record. • Give them a chance to ask questions about the process. • Get verbal consent: "You have read the information in this consent form. You have had the chance to ask questions about this study, and those questions have been answered to your satisfaction. You are at least 18 years of age, and you agree to participate in this research project. You understand that your verbal acknowledgement indicates your informed consent." • Mention the respondent's number (i.e., you are respondent #2).
General Questions about Majors	1. Currently you are a senior at {your school} and you are majoring in {your major}. Correct? 2. If they are a double major a. Why did you decide to double major? b. Which major do you consider to be your primary major? From this point forward consider their primary major to be their major unless they have one STEM and one non-STEM major. In that case, consider them a STEM major and ask questions based on that major. 3. We are interested in hearing the story of how you came to major in {your major}. Thinking back over the course of your life, what contributed to your becoming a {your major} major. 4. What do you think was the most influential factor in your decision to major in {your major}? 5. When did you first know you would major in {your major}? 6. Did you have any career/life plans in mind when you chose {your major}? If yes: a. What were the reasons behind your career plans? b. Did you see this major as fitting in with these plans? If so, how? If not: then go on to question #7: 7. What kind of career/life plans have you made since you decided to major in {your major}? a. Did you see this major as fitting in with these plans? If so, how? b. If planning a career in science … what about a career in science appeals/does not appeal to you? c. If not planning a career in science …. Assuming you had the

	qualifications to do it, what aspects of a job related to science would appeal to you? 8. How did you come to attend {your current school}? 9. What other majors did you consider? Why did you not pursue a major in those areas? 10. Are you happy with your decision to major in {your major}? Would you pick a different major if you could start as a freshman again? (if so, why and what major would you pick?) 11. Has your ability to pay, or the way you pay, for your college education impacted what you majored in? 12. Over the course of your life, what experiences stand out as encouraging you toward majoring in {your major}? 13. Over the course of your life, what experiences stand out as discouraging you toward majoring in {your major}? 14. How does your family feel about your decision to major in {current major}? Probe to explain if they don't. 15. (a) (For science majors) Why did you not choose other areas of science as your major? If not addressed Why did you not choose physics? Why did you not choose computer science? 15. (b) (for engineering majors) Why did you not choose other areas of engineering? If not addressed Why did you not choose mechanical engineering? Why did you not choose computer science? Do you feel there are more prestigious fields of engineering? If so which ones? Has this impacted your majoring decision in any way? 15. (c) (for computer science majors) Why did you not choose science or engineering?
Interest in Science	1. How interested were you in science when you were very young? What contributed to this interest or lack of interest? a. {If not mentioned} How did your family influence your interest? b. {If not mentioned} How did your experiences at school influence your interest? 2. How did that interest level change as you went through middle and high school? Explain. 3. Since you started college, has your interest in science in general and your major (if a science major) increased/decreased? If so, what do you think contributed to this shift?
Pedagogical Experiences and Interactions with Teachers	1. Did you take more math and/or science classes in HS than what was required for graduation? Why or why not? (i.e. personal interest, external expectations from family, society, college admissions, etc.) 2. Did you enjoy your math classes in HS? Why or why not? 3. Did you enjoy your science classes in HS? Why or why not? 4. Do you feel your HS math classes were taught well? Why or why not? 5. Do you feel your HS science classes were taught well? Why or why not? 6. If not mentioned for (4) and (5) above, follow with a. Do you think your math and science teachers in high school were interested in teaching? Explain.

	b. Do you think your math and science teachers cared about you and your learning? Explain. c. Probe (if necessary): could you provide an example of one-on-one interaction that made it seem like one of them cared about you and your learning? d. To what extent did your math and science teachers lecture vs. use more active approaches such as, encouraging student discussion, cooperative learning and hands on activities? Would you have preferred a different emphasis? e. Did any of your math and science teachers stand out as being very influential in your choice of major, positively or negatively, why? 7. Did you enjoy classes in {their major} you took in college? 8. Do you feel your {major} classes were taught well? Why or why not? 9. If not mentioned for (8) and (9) above follow with a. Do you think your {major} instructors at college enjoyed and were interested in teaching? Explain. b. Do you think your {major} instructors cared about you and your learning? Explain. c. To what extent did your {major} teachers lecture vs. use more active approaches such as, encouraging student discussion, cooperative learning and hands on activities? c. Would you have preferred a different emphasis?
Identity and Confidence Issues	1. Do you feel you have the ability to complete a math/science major as well as others? Have your feelings about your ability to do math/science changed over time? If so, what led to these changes? 2. How have your teachers /professors viewed your abilities to do {your major}? Did they think you are more or less able than you think you are? Do you feel their views have changed over time? Explain. 3. How have your peers viewed your abilities to do {your major}? Did they think you are more or less able than you think you are? Do you feel their views have changed over time? Explain. 4. Describe a typical {major} major. 5. Do you feel like you belong/belonged in {your major}? Did you ever feel out of place? Has this feeling changed over time, and if so, what led to these changes? 6. How often do you socialize with people who are {your major} majors? Do you enjoy socializing with typical {major} majors? 7. How often do you study with other students in {your major}? Do you think you are more or less connected to your classmates than a typical student in {your major}?
Gender and Race Questions	1. Roughly speaking, what was the track level of most of your high school math & science classes [ie., AP, IB, honors, regular, gifted, etc]? a. what percent of students were female? b. what, if anything, did the gender composition of your HS science [& math] convey or signal to you in terms of becoming a STEM major? c. did its gender composition affect your comfort level in the class? 2. Roughly speaking, what percent of students in your high school math and science classes were like you in terms of race?

	a. what, if anything, did the racial mix of your HS science [& math] classes signal/convey to you in terms of becoming a STEM major? b. did its racial composition affect your comfort level in the class? 3. What is your best "guesstimate" of your high school's racial composition? [i.e., diverse, majority white, majority, black, really integrated, etc] 4. Roughly, what percent of students in your major are like you in terms of gender 5. In terms of race? 6. Do you think the experience of pursuing a {your major} major is different for men and women? If so how? 7. Do you think the experience of pursuing a {your major} major is different for people of different races? If so how?
Family Experiences	1. How would you describe the structure of your family of origin growing up? a. Did you come from a single parent household? b. Did your parent(s) complete high school? College? c. Would you consider your family of origin to be low-income, middle class, upper class? d. Did extended family members live with you? e. How did these structures influence your decision to go to college? Major in STEM? 2. Did you have support systems [moral, financial, spiritual, academic] while in college? a. Where did they come from? 3. What are some of the values that your family stressed about education? How did they convey the values to you? 4. What were your family's academic performance expectations of you? How did they convey the expectations to you? 5. What role, if any, did your family play in you going to college? In pursuing a STEM degree? a. Did your mother/grandmother/aunt influence your decision to go to college/pursue a STEM major in any way? If so, how? b. Did your father/grandfather/uncle influence your decision to go to college/pursue a STEM major in any way? If so, how? 6. Did your family support your pursuit of a STEM degree? If so, how? If not, why? 7. Were there times during undergrad that you contacted your family for support? a. If yes, how did they help support you [moral, financial, spiritual, academic]? 8. Did the values (human capital, social capital, etc) that were instilled by your family impact how you performed in your STEM courses in college?
Final Question (s)	1. We are interested in learning about why people major or don't major in science, technology, engineering, and mathematics. Is there anything else along these lines that we have not asked about that we should have? 2. Thank them for participating and remind them to send in their vendor information form.