WHO I AM IN STEM: BEING AFRICAN AMERICAN, A COMMUNITY COLLEGE TRANSFER STUDENT, AND A STEM MAJOR

by

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ABSTRACT

YOLANDA KENNEDY DOUNEBAINE. Who I am in STEM: Being African American, a community college transfer student, and a STEM major (Under the direction of DR. LISA MERRIWEATHER)

This qualitative research study utilized the stories of ten African American community college STEM transfer students to explore STEM identity formation, the role race played in this identity formation, the educational experiences that influenced the development of a STEM identity, and how the STEM identity aided in their persistence to STEM degree completion. This study explored perceived factors that affected persistence for African American community college transfer students, and compared and contrasted these findings to foundational theories on persistence across a broad audience, and to those that took into account challenges faced by specific minority communities.

Three major themes emerged from this study: 'STEM is a Part of Who I Am', 'Breaking Through Barriers', and 'Even if I Am the Only One, I Have Support'. The findings from this study suggested that STEM identity was solidified by an internal sense of belonging in STEM and highlighted the importance of human interactions in the formation of STEM identity, and positive educational experiences stemming from early childhood. The student's connection with STEM identity seemed to be one of the strongest motivators to encourage resilience, which resulted in persistence. The implications for this research provided data to support cultivation of educational environments that are inclusive and supportive of minority students in STEM educational environments.

DEDICATION

This study is *dedicated* to *my family, friends, and all students of color who are fighting for their dreams through a STEM focused program*. First and foremost, I have to thank *my parents, Dr. Yvette and Arnold Kennedy* for *their* love and support throughout *my* life. Thank you both for giving *me* strength and encouragement to pursue anything I put my mind to, and making me believe that even as a young child, obstacles did not exist. I would like to thank my husband, Dr. Bonheur Dounebaine and my siblings Maya Ramos, Dr. Ivana Parker, Dr. Amber Rushworth, and Joseph Kennedy for their continued support along the way. Last but not least, I would like to thank the students who participated in my study: Stacy, Eric, Maya, Lynette, Joseph, Lauren, Ariel, Jamie, Tyler, and William. Their stories of persistence, determination and grit in STEM will inspire and encourage others as they embark on a STEM journey as an African American community college transfer student.

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"It always seems impossible until it's done."

— Nelson Mandela

Without God, this journey would have been impossible, but God provided the people and resources I needed at every stage of this journey and for that I am thankful!

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CHAPTER 1: INTRODUCTION

Over the last century, significant advances in technology have resulted in a more connected society. As the world migrates to a knowledge sharing economy with the evolution of technology, workers with skills in science, technology, engineering, and math have become integral to the nation's economic competitiveness and innovation (Falkenheim & Hale, 2015; National Science Board, 2018). The United States is trailing behind their international counterparts in producing workers with the skills needed to compete in the global markets. In China, 49% of all first university degrees were awarded in science and engineering in 2012, compared to 33% in the United States (Falkenheim & Hale, 2015). Globally, the number of bachelor's degrees awarded in science and engineering reached about 6.4 million, with China accounting for 23%, India at 23%, the European Union contributing 21%, and the United States at only 9% (National Science Foundation, 2017).

In 2017, the majority of the United States population consisted of 61% Whites, 18% Hispanics, 13% Blacks and 6% Asian, with less than 3% of the population identifying as American Indian, unidentified racial category, or two or more races(U.S. Census Bureau, 2017). Bachelor degrees awarded in 2015 somewhat mirrored the population demographics with the distribution of degrees and racial categories totaling: 67% Whites, 12% Hispanics, 11% Blacks and 7% Asian (Falkenheim & Hale, 2015). Unfortunately, when the degrees awarded were broken down into fields, it was highly disproportionate. While there is an increase of participation in the STEM fields, specific areas within STEM are highly represented by White students. Table 1.1 shows the most recent data on the distribution of bachelor's degrees awarded in 2014 by race and

ethnicity. The most racially unbalanced field was physics, with Whites totaling 60% of the bachelor's degrees awarded in 2014, while Black and Latinx students made up about 10% of the population together. Asians accounted for 6% of the field and 12% identified as unknown. Racially unbalanced fields were a trend in agriculture, biological, computer, and physical sciences, and racial disparities in degrees awarded existed across all disciplines in STEM, as demonstrated in Table 1.1.

Table 1.1
Percentage of Science and Engineering Bachelor's Degrees Awarded 2014 to US Citizens and Permanent Residents, by Race/Ethnicity

		Major						
Race/Ethnicity	Population Distribution	Agri Science	Bio Science	Comp Science	Phys Science	Chem istry	Physics	Eng
White	61	78	59	58	65	60	70.6	66.9
African American	9	3	8	10	6	7.6	3.1	4.2
Asian American/Pacific Islanders	10	4	13	10	10	15	6.4	11
Hispanic American	12	7	10	10	8	9.1	7	10
Indian/Native American	0.5	1	0	0	0	0	0	0
Unknown	8	7	7	12	9	8.3	12.9	6.8

Source: National Science Foundation, National Center for Science and Engineering Statistics. 2017. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017. Special Report NSF

While institutions of higher education have improved the educational attainment of bachelor's degrees for minorities and women in STEM, there are still major disparities in STEM bachelor degree attainment.

Statement of the Problem

The community colleges' success at enrolling non-traditional populations in their programs has drawn the attention of policymakers and educational leaders. As research examining the K-20 pipeline has become very popular, there has been a big push to utilize these institutions to meet the need of producing more college-educated people. (Bailey, Calcagno, Jenkins, Leinbach, & Kienzl, 2006; Calcagno, Crosta, Bailey, &

Jenkins, 2007; Townsend & Wilson, 2006). Although the community college model has shown success in its ability to attract students from historically marginalized groups, this success has been overshadowed by the low persistence and success rates of the students enrolled when utilizing traditional student success measures (Radford, Berkner, Wheeless, & Shepherd, 2010).

Community colleges continue to strive to increase equity for marginalized groups in higher education and attract a diverse population of students. According to the American Association of Community Colleges (2018), in 2015, minority students made up a significant percentage of the community college population (56% of Native American, 52% of Hispanic, 43% of Black, and 40% of Asian/Pacific Islander). This is supported by the research of Cohen and Garcia (2014) which concluded that community college student populations are more likely to reflect the ethnic composition of the institution's locale than the 4-year universities, and that community colleges located in cities with a high proportion of minorities tend to enroll sizable numbers of minority students.

Although community colleges attract a diverse group of students, there are concerns about the successful transfer rate of minority community college students to 4-year universities. Research conducted by Bailey, Jaggars and Jenkins (2015) concluded that after six years of enrollment at a community college, less than 40% of community college students earned a certificate or degree, and the successful transfer rate of minority students was even lower. In 2009, of all the students who transferred to a four-year university and majored in STEM, less than 1% identified as American Indian, 8% identified as Hispanic, 10% identified as African American, and 16% identified as Asian.

The other 62% reported as White (Palmer & Wood, 2013). The findings from these studies implied that although community colleges have been more successful at recruiting wider demographics, this success is not translating into a higher number of STEM bachelor degrees for students.

With the community college's success at attracting minority groups, it is crucial for researchers to address barriers to community college student persistence at four-year institutions, especially for minority students. In order to understand the success of students in STEM majors from underrepresented minority (URM) groups that successfully transfer to four-year universities from the community college, there is a need for more research to identify the educational experiences and major influences on student persistence for these groups of students.

Purpose of the Study

The purpose of this study was to explore how African American community college transfer students, who majored in STEM, developed a STEM identity, and how their educational experiences influenced the development of that identity. This study looks specifically at STEM persisters and their experiences in higher education. The research questions that guided this study were:

Research Questions:

1. What educational experiences do African American community college transfer students, majoring in STEM at the university level, perceive as most important to their persistence in STEM?
2. How do African American community college transfer students develop their STEM identity?

3. How have the educational experiences of African American community college transfer students influenced the development of their STEM identity?
4. How does race influence the development of STEM identity in African American community college transfer students?

Significance of the Study

The National Science Foundation (NSF) and the National Center for Science Engineering Statistics (NCSE) identified the increased persistence and retention of students from underrepresented minority groups (URM) in STEM majors as a possible solution to the STEM workforce deficit (Falkenheim & Hale, 2015). Well-known student persistence and retention theories have examined the importance of factors like institutional climate, culture, academic and social integration on STEM persistence (Allen-Ramdial & Campbell, 2014; Astin, 1984; Bean & Eaton, 2001; Pascarella & Terenzini, 1980; Tinto, 1993). These factors, coupled with a strong STEM identity, has increased the persistence of African American students in the STEM field (Carlone & Johnson, 2007; National Academies of Sciences, Engineering, and Medicine, 2016). This study explored one aspect of these theories in one URM group: the STEM identity of African American students who utilized the community college system in their educational journey to a STEM bachelor's degree.

Theoretical Framework

This study took a microscopic look at the STEM identity of African American students who transferred from the community college. In order to understand the history of African Americans and the racial disparities in the education system, it is important to examine American history and the role race has played in shaping American society.

Hardiman, Jackson, and Griffin (2007) posit that people of color have been oppressed in the United States since its existence and this oppression operates on multiple levels. The authors wrote, “oppression is an interlocking, multilevel system that consolidates social power to the benefit of members of a privileged group" (p. 39). Social institutions, such as government and legal systems, are major participants in a system of education. It is through these institutions that America created and solidified systems of oppression and inequity in education. Even as America withdrew laws that blatantly discriminated against people of color during the Civil Rights era in the 1950s, the 100-year history of racism and oppression remained embedded within the political and social systems in America. Therefore, while there continues to be major disparities in the representation of African American students in STEM, one must examine this disparity within a historical context of how race impacts higher education.

For these reasons, this current research was rooted in Critical Race Theory (CRT), a theory that analyzes the role race and racism play in social disparities between dominant and marginalized racial groups (Ladson-Billings & Tate, 1995). Critical Race Theory, known for its use in legal studies by scholars like Derrick Bell Jr., Alan Freeman, Richard Delgado and Mai Matsuda, explores the intersection of race, law, and power (Yosso, 2005). Critical race theory migrated into other fields in the late 1980s and was used as an analytical framework to assess inequity in education in the 1990s (DeCuir & Dixson, 2004; Ladson-Billings & Tate, 1995). Gloria Ladson-Billings and William Tate (1995) were among the first scholars to apply Critical Race Theory to educational studies in order to examine disparities in society attributed to race. CRT is known for its foundational belief that racism is ingrained in the fabric and systems of American society.

This includes the dominant culture influences and power structures based on White privilege and White supremacy. CRT scholars have described this theory by five major themes (Ladson-Billings, 1999; McCoy & Rodricks, 2015; Yosso, 2005).

1. Counter-Storytelling - Counter-stories are personal, composite stories or narratives of people of color (Delgado & Villalpando, 2002). Counter-storytelling gives voice to marginalized groups that can expose and critique the dominant ideology, which perpetuates racial stereotypes.

2. Racism is Permanent - The ideology that racism controls the political, social, and economic realms of U.S. society (Hiraldo, 2010). It is the idea that racism is normal and it is normalized in American culture (Ladson-Billings, 1998).

3. Whiteness as Property –Whiteness can be considered as property and comes with benefits that include the right of possession, the right to use and enjoyment, the right to disposition, and the right of exclusion (DeCuir & Dixson, 2004; Ladson-Billings, 1998; Ladson-Billings & Tate, 1995).

4. Interest Convergence Theory – The theory acknowledges how the dominant group is generally the primary beneficiary of legislation geared toward societal inequities ((DeCuir & Dixson, 2004; Ladson-Billings, 1998). DeCuir and Dixson (2004) argued, "early civil rights legislation provided only basic rights to African Americans, rights that had been enjoyed by White individuals for centuries" (p. 28). CRT informs us that the interests of African Americans are promoted when there is a convergence with the interests of those in power (McCoy & Rodricks, 2015). For example, the major push to increase STEM participation from minority groups is based on the United States' desire

to be competitive in the global market, but does not consider the social inequities that initially created a gap in a field dominated by White males.

5. Critique of Liberalism –The critique of liberalism stems from the ideas of colorblindness, the neutrality of the law, and equal opportunity for all (DeCuir & Dixson, 2004; Hiralo, 2010). Because rights and opportunities are withheld almost exclusively on race, the idea that the law is indeed color blind and neutral is insufficient. Colorblindness is a mechanism that allows people to ignore racist policies that perpetuate social inequity (DeCuir & Dixson, 2004). Color-blind ideology presumes or asserts a race-neutral social context (Bonilla-Silva, 2001). It stigmatizes attempts to raise questions about amending racial inequality in daily life through accusations such as "playing the race card" or "identity politics," which imply that someone is trying to bring race in where it does not belong (Bonilla-Silva, 2001). It also involves the technique of non-recognition, the implied process of noticing, but not considering race (Crenshaw, 1997).

Hiraldo (2010) explains the need for race and racism to be included in the analysis of academic success and achievement of African American students. Therefore, this current research used CRT to provide a contextual view of the relationship between one of the underlying issues of the disparities in the representation of minority groups in STEM and America's history with race relations' impact on education. Furthermore this study utilizes critical race theory with an anti-deficit achievement lens that was developed by Harper (2010). Harper's (2010) anti-deficit achievement lens focuses on achievements of minority groups in STEM. This anti-deficit lens prompted minority STEM achievers and persisters to discuss the persons, resources, experiences, and opportunities to which they

attribute their achievements instead of continually having them identify solely barriers to success in STEM.

Methods

Gay, Mills, and Airasian (2009) defined qualitative research as, "the collection, analysis, and interpretation of comprehensive narrative and visual data to gain insight on a particular phenomenon of interest" (p. 7). This research study employed a qualitative approach using the critical paradigm of CRT as a lens to view the data collected. The data was collected by conducting interviews with African American students, who attended a community college and transferred to a four-year school to major in STEM.

Interviewing was chosen as the method of collecting data because it is one way to practice counter-storytelling, a method derived from CRT (G. Ladson-Billings, 1998). Solórzano and Yosso (2002) defined counter-storytelling as "a method of telling the stories of those people whose experiences are not often told" (p. 26). A total of ten interviews were conducted with students who met the criteria for participation: (a) identified as African American, (b) transferred from a community college to a 4-year university, and (c) declared a STEM major at some point during their post-secondary education.

Subjectivity Statement

I identify as an African American female, who grew up with a strong interest in the STEM fields. This interest was fueled by my parents' earned degrees and work in the STEM fields. My dad, a computer engineer, always talked about his journey into the engineering field. Interestingly enough, one of his high school math teachers recognized his inclination toward math and suggested he become an engineer. At that time, my dad

had no idea what an engineer was and thought that he would be working on trains. Although he had no idea why, he majored in engineering, and today he works as a computer engineer. Likewise, my mom obtained a Doctorate of Optometry. During her educational journey, she utilized the community college to achieve her goals. Growing up in a STEM-focused environment resulted in each of my siblings obtaining either a STEM Bachelor's, Master's or Doctorate degree.

I am the only sibling who did not pursue a STEM major. I loved math at an early age, I majored in Accounting at the University of North Carolina Charlotte. Always drawn to entrepreneurship, I believed that a degree in Business would benefit that interest. Although I was still very interested in math and planned to minor in Math for Business, after the second day in the Calculus II class I dropped the course. I had no idea what was going on and could not understand the professor's accent. After obtaining a Bachelor's in Accounting, I migrated to Education and took an interest in research.

I am also very aware of my racial identity. Both of my parents were raised in the Deep South during the aftermath of Jim Crow. Their life experiences were blatantly impacted by race. My grandfather was one of the first African American bus drivers in Montgomery after the Montgomery bus boycott. My grandmother marched with Martin Luther King Jr., and attended his church. I grew up very aware of racial identity and how it impacted my experiences.

My childhood experiences, educational journey, and environment influenced the topic of this study. I know the struggles my parents and siblings endured to obtain their degrees as African Americans in the field. It was the goal of this study to explore the

motivators for success through the stories of African American students who persisted and who used the community college pathway to pursue a STEM degree.

Assumptions

As this study utilized counter-storytelling, one of the major assumptions was that participants were honest during the interviews. Confidentiality throughout the study was maintained. A relaxed interview atmosphere was created to make the participants feel comfortable in sharing their authentic experiences. Another assumption of this research was that the students selected for the study would be transparent in sharing their experiences so that the findings would add to the body of literature surrounding African American community college transfer STEM experiences and the development of their STEM identity.

Limitations

This study utilized a small sample size to deeply explore the experiences of the students, and therefore more studies would be necessary to ascertain if this study is generalizable to a broader population. Data was collected at one 4-year university within the University of North Carolina College and University System (16 campuses). Therefore, results from other places in the country may differ depending on the demographics and population of the region. The last limitation of this study is researcher bias. Since the researcher was the primary source of data collection and analysis, member checking and memoing was utilized to reduce potential bias.

Delimitations

The participants in this study were limited to African American student persisters who transferred from a community college to a 4-year university and pursued a STEM.

Key Terms and Definitions

For the purpose of this study, the following definitions were used:

1. African American (Black) – a person who self-identifies as having origins of any Black racial group in Africa.
2. Community College – a non-residential two-year college in which you can earn an Associate degree.
3. Institutional climate – the practices, behaviors, perceptions, attitudes, and expectations that determine the prevailing attitudes in the environment (Allen-Ramdial & Campbell, 2014).
4. Institutional culture - the collection of shared values and beliefs that act as a blueprint to guide actions, and subsequently establishes climate (Allen-Ramdial & Campbell, 2014).
5. Persistence - the continual pursuit of a student in a degree program leading toward the completion of the program (Astin, 1984; Bailey et al., 2006).
6. STEM – the various disciplines in science, technology, engineering, and mathematics. These disciplines include: mathematics, statistics, computer/information science, computer programming, electrical, chemical, mechanical, civil, or other engineering; engineering technology; electronics, natural resources, forestry, biological science (including zoology), biophysics, geography, interdisciplinary studies including biopsychology, environmental studies, physical sciences including chemistry, and physics (Anderson, Sun, & Alfonso, 2006).

7. Underrepresented Minorities (URM) –relates to communities of color that are not numerically represented in the STEM fields as proportioned to their composition in populations in the United States; African Americans, American Indians/Alaska Natives, and Latinx— who have historically comprised a minority of the U.S. population (NACME, 2018).

Organization of the Study

Chapter 1 discussed the need for this research in higher education, the problem, the purpose of the study, the significance of the study, the research questions, the theoretical framework and operational definitions. Chapter 2 provides a comprehensive review of the current and relevant literature on models of persistence in STEM, student success, institutional factors that influence student success for minority students in underrepresented areas, participation of minorities in STEM and the development of a STEM identity. Next, Chapter 3 provides a detailed description of this study's research methodology, theoretical framework, research design, research sites, participant selection, data collection procedures, data analysis procedures, and justifications of the methodology. Chapter 4 presents an overview of the findings of the current study that resulted in three major themes: 'STEM is a Part of Who I Am', 'Breaking Through Barriers', and 'Even if I Am the Only One, I Have Support'. Lastly, Chapter 5 discusses the study's findings in relation to the development of STEM identity and STEM persistence for African American community college transfer students, implications for further research, and the conclusion of the study.

CHAPTER 2: LITERATURE REVIEW

The purpose of this study was to explore how African American community college transfer students, who majored in STEM, developed a STEM identity, and how these students' educational experiences influenced the development of STEM identity for STEM persisters. The pages that follow provide an examination of the literature presenting the key concepts of this study. This chapter begins with the historical context of race within America and explores how it impacts the education sector. The second part of this chapter presents widely known student persistence and retention theories as it relates to post-secondary student success, highlighting the role of STEM identity in student persistence. The third portion of this literature review provides an overview of the major concepts and theories that are commonly associated with the success of students in STEM. This section includes a summary of research studies related to the success of community colleges with underrepresented minority groups in STEM and the current transfer landscape for STEM students. This review of the literature will discuss STEM identity, the culture of STEM, and student success pathways for URM STEM students.

Historical Context

Because Critical Race Theory was the theoretical framework for the study, it is important to provide the context of race in the United States of America. According to Smedley and Smedley (2005), race is a socially constructed category created to differentiate racial groups and show the superiority or dominance of one race over another. In America, race was widely used as a reference for social categories of Indians, Blacks, and Whites (Bonilla-Silva, 2001; Smedley & Smedley, 2005). Race signified an

ideology about human differences and was a new way of structuring society to create a hierarchical relationship between people of color and Whites (Bonilla-Silva, 2001). This hierarchy supported the slavery of Africans and non-whites.

Before the Emancipation, slaves were not allowed to read and in some counties it was considered a criminal offense to teach a slave to read (Duster, 2009). After the Civil War and the abolishment of slavery, hundreds of new communities of former slaves perceived education as a means to a better life, and in that first decade of Reconstruction the rates of literacy among Blacks increased (Duster, 2009). Northern troops were sent to occupy southern counties to facilitate the abolishment of slavery in the southern states. This created a level of security and support for newly freed slaves to pursue goals of education that were once outlawed. Unfortunately, these advancements halted with the Tilden-Hayes Compromise of 1877. This compromise led to the withdrawal of northern troops in the south and the end of Reconstruction, which gave an opportunity for white supremacy and terror to, once again, be ingrained in state and local laws. As a result, the advancement of African American communities halted with the creation of Jim Crow laws, and specific laws in the south that were used to enforce racial segregation and humiliation (Duster, 2009). Jim Crow schools were created for Black children in which they were mainly taught service and domestic skills.

In 1896, the U.S. Supreme Court's decision in *Plessy v. Ferguson* established a "separate but equal" doctrine in public education. This doctrine encouraged Black colleges, both public and private, to offer more courses on teacher training so there would be enough teachers to serve the children attending the separate Black schools (Ficker, 1999;Historically Black Colleges and Universities and Higher Education Desegregation,

2015). These public and private institutions served the mission of providing education for teachers, ministers, lawyers, and doctors for the Black population in a racially segregated society.

In 1964, President Lyndon B. Johnson signed the Civil Rights Act of 1964. Title VI of the Act stated that "no person in the United States, on the grounds of race, color, or national origin, be excluded from participation in, or the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance" (Malaney, 1987). Title VI also restricted the distribution of federal funds to segregated schools, which provided an incentive for schools to desegregate.

Another piece of legislature that fueled desegregation during this time was the Higher Education Act of 1965. Title III of this Act provided funding for faculty and curriculum improvement, student services, exchange programs for faculty and students, and various administrative improvement policies at Historically Black Colleges and Universities (HBCUs) (Harper, 2009). Desegregation of the higher education system allowed Blacks to enroll in Traditionally White Universities, but many of the systems and policies within the University remained the same. During the desegregation process, in many states, Black students were met with resistance from their White peers, especially in flagship state schools in the Deep South states of Alabama, Georgia, Mississippi, and Louisiana (Wallenstein, 2008). Because the southern states had the highest proportions of Black citizens, Whites feared the loss of power and privilege that accompanied desegregation. According to Wallenstein (2008), desegregation was a lengthy process on college campuses and lasted from the 1930s into the 1970s. Even today, it can be argued that full inclusion has still not been accomplished. Understanding desegregation as a

drawn-out process that was unwillingly and unevenly implemented in higher education can be useful in understanding patterns in the 21st century (Wallenstein, 2008).

Research showed that it can be difficult for students from a cultural minority group to achieve a sense of ownership within the academic community, particularly at Traditionally White Institutions (Turner, 1993). Culturally biased policies and practices contributed to cultural alienation for minority students at some of these universities (Swail, 2003; Torres, 2004). For these reasons, this literature review explored the factors that impacted student success, persistence, and ultimately a student's STEM identity.

Student Success

In higher education, student success has been defined and measured within multiple constructs. While student success has been defined through traditional measures, including academic achievement, many have been defined by the ultimate measure of student success as degree completion (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2011). Research showed that student success is directly impacted by a variety of factors, such as enrollment in postsecondary education, grades, persistence to the sophomore year, length of time to degree, and graduation (Venezia & Kirst, 2005).

Swail (2003) identified student success as a major component of student persistence. Student persistence is a concept that focuses on the effort a student exhibits throughout a college degree program while taking into account the institutional, pre-collegiate and environmental factors that affected student's ability to complete one semester and continue to the next (Astin, 1984; Bailey et al., 2006). When institutions focus on student success, they examined retention, or how well their institutions retained students from semester to semester until degree completion. According to Hagedorn

(2005), the National Center for Education Statistics differentiated the terms by using "retention" as an institutional measure and "persistence" as a student measure. Many sociological, organizational, and cultural theorists examined student success, persistence, and retention through a variety of lenses. The most popular theories were Tinto's (1975, 1987, 1993) Interactionalist Theory, Astin's Student Involvement Theory, and Bean and Eaton's Model of Student Departure.

Popular student persistence theories explained factors that influenced student success and retention. Tinto's Interactionalist Theory was the dominant sociological perspective, creating a foundation for other scholarly research on student retention (Braxton, Sullivan, Johnson, & Smart, 1997; Pascarella & Terenzini, 2005). Tinto (1993) theorized that students must first separate from the group with which they were formerly associated, such as family members and high school peers. During this process, students undergo a period of transition and assimilate into the institution by adopting the norms, values, and behaviors of the college or institution (Tinto, 1993). Tinto asserted that students who leave college are those who are unable to effectively distance themselves from their family or community of origin and adopt the values and the behavioral patterns of the colleges they are attending.

Tinto's (1993) model also highlighted the importance of academic and social integration in student retention. Earning passing grades represented a measure of academic integration. Social integration was defined as how well a student socially integrated into the institution, which is heavily influenced by a student's background, values, aspirations, and relationships made with other faculty and students at the institution. He defined student persistence as a function of dynamic relationships

between the individual and other actors within the college and their home community. Tinto (1975) proposed that increased levels of academic and social integration led to a more significant commitment to the institution and the goal of graduation. According to his model, persistence occurred when a student successfully integrated into the institution academically and socially, while integration was influenced by pre-college characteristics and goals, interactions with peers and faculty, and out of classroom factors. The model emphasized the importance of the student's commitment to their goals and institutional commitment.

Pre-collegiate characteristics that were important in this model included a student's individual attributes, pre-college experiences and family background. Individual attributes included variables such as race, sex, academic ability, and pre-college experiences referred to the social and academic experiences of a student, like their school grade point average and academic and social attainments. Family background covered factors like social status, value climates, and family expectations. Tinto (1975) also asserted that while the individual's social and academic integration were important determinants in whether or not a student persisted in higher education, it was the interaction between the students' individual commitment to the goal of college completion and their commitment to the specific educational institution, which determined whether or not they dropped out. Tinto's (1975) model was coined as a foundational piece in student persistence research.

Over time, student persistence models emerged and evolved. Spady (1970), one of the seminal authors on student integration, developed the Sociological Model of Student Dropout. This model measured the impact of academic potential, normative congruence

(the degree to which the individual's personality is typical), grade performance, intellectual development, and friendship support on social integration. Tinto (1975) furthered Spady's (1970) theory with the development of the Model of Student Integration. Tinto's (1975) model explored student attrition and how success in a student's pursuit of higher education influenced the level of commitment the student had to an institution and their academic and career goals. Over the years, Tinto kept improving his student attrition models. One of the most widely utilized models is the Model of Student Departure (Tinto, 1993), which focused on the influence of academic and social integration on student departures and dropouts.

Similarly, Bean (1985) created a model that applied a theory based on organizational behavior to student attrition that theorized why students left school. Bean's theory compared student attrition to employee attrition. Bean's model suggested that student attrition was affected by student background variables, interaction by students within the institution, the influence of environmental variables, students' perceived quality of self-satisfaction, and students' intention (i.e., transfer and degree attainment). Bean's model expanded Tinto's model by integrating academic variables, student intent, goals, expectations, and external and internal environmental factors into a revised model of persistence (Bean & Metzner, 1985).

Pascarella and Terenzini (1980) focused on the importance of the Student Involvement Theory from the perspective of student interactions with faculty and peers. They provided a causal relationship model addressing both direct and indirect effects of student involvement and interaction. In this new model, Pascarella, (1986) furthered Tinto's (1975) model and focused on the interactions and interrelationships between

students and faculty, finding that the amount of time spent with faculty, both in and out of the classroom, strongly influenced student intent and persistence. Pascarella and Terenzini's (1980) Student Involvement Theory measured student involvement by examining how the interactions and interrelationships between students and faculty influenced student intent and persistence. The authors found that the amount of time spent with faculty, both in and out of the classroom, strongly correlated with the factors listed above.

Both, Pascarelli and Terenzini (1980) and Astin (1984) created models that focused on student involvement and its impact on student persistence. Astin's (1984) Student Involvement Theory examined how the input, outputs, and environments of college influenced educational outcomes such as academic achievement, retention, and graduation. For example, a student's personal, background, and educational characteristics could impact student success in post-secondary education. Major factors often found related to student retention include academic preparation, academic engagement, social engagement, financing college, and demographic characteristics (Astin, 1984; Bean & Metzner, 1985; Swail, 2003; Tinto, 1993). A summary of these theories is included in Figure 1.1.

Theory	Author	Factors	Outcome
Sociological Model of student Dropout	Spady (1970)	Academic potential, normative congruence, grade performance, intellectual development & friendship support	Social Integration
Model of Student Integration	Tinto (1975)	Student success influenced the level of commitment a student has to an institution, academic goals and career goals	Student Attrition
Pascarella and Terenzini Student Involvement Theory	Pascarella & Terenzini (1980)	Interactions and relationships between students and faculty; and persistence	Student Involvement
Astin's Student Involvement Theory	Astin (1984)	Environments of college: personal, background, and educational characteristics that students brought with them to postsecondary education	Academic Achievement Retention, and Graduation

Figure 1.1: Popular Student Persistence and Retention Theories

Although Tinto's model has been heavily praised and utilized as a foundational piece, there has also been major criticisms. One criticism was that the model was only designed for traditional residential students (Metz, 2004) and could not be applied to all groups. For example, this theory did not account for students at two-year schools (Cabrera, Castaneda, Nora, & Hengstler, 1992) or minority groups.

Deil-Amen (2011) applied Tinto's Theory of Student Departure to students at a two-year school to see if the model held true, which it did but utilizing different measures. She found that socio-academic integrative experiences influenced the type of integration Tinto (1993) defined as a sense of "competent membership" (p.97). Socio-academic integrative experiences were described by Deil-Amen as:

> (a) ranges of in-class interactions and dynamics, formal or "spontaneous" study groups; (b) social-capital relevant interactions and mentor relationships with trusted faculty or other staff; (c) consistent access to communication with "similar" students (usually facilitated by some form of cohort scheduling that created consistency in the students that interacted with each other from one term to the next, and, to a lesser extent; and (d) academically-relevant clubs and activities (p.81).

Because two-year students were predominantly at community colleges and were still living in their local community, social-academic integrative experiences helped students to merge academic success into their social identities and find balance between their studies and extra-curricular demands. Deil-Amen (2011) posited that the dynamics of race, class, and culture should be further explored in two-year contexts while utilizing Tinto's concept of integration to frame the discussion.

Rendón, Jalomo and Nora (2000) challenged Tinto's perspective that student retention is solely based on student' ability to integrate and assimilate into the institution and offered the concept of dual socialization. According to this concept, institutions shared responsibility in the successful cultural and social integration of students into college. Rendón et al. argued that the assumption that minority students are responsible for assimilating into college culture excuses institutions from dealing with their contribution to creating barriers to retention. Kith and Love (2000) found that students, who made cultural connections through social groups that reflect their culture of origin, were more likely to persist in higher education. Tierney (2000) asserted that students should not have to leave their identity at home while furthering their education. Instead, these students should be provided with the cultural capital necessary to succeed in an educational system where barriers to persistence and integration exist for minority students.

Within the notion of success in higher education and student retention theories, understandings of minority populations and worldviews are often excluded in institutions where mainstream culture and values dominate (Jensen, 2011; Kith & Love, 2000). Acknowledging these populations and their perspectives could greatly inform the development of broader and more effective theories of retention (Jensen, 2011; Kith & Love, 2000; Tierney, 2000). Examining the power dynamics between dominant and minority cultures in colleges may create a better understanding of cultural integration and student success in higher education.

Student Success of African American Students in STEM

As student persistence theories evolved, the success of different populations of students were examined. Student success within American Indians/Alaskan Natives, Blacks, and Hispanics has been explored due to their underrepresentation in the STEM field. Student success literature on African American students studying a subject in the STEM field was commonly found among STEM research looking within URM groups.

An initial literature search, pairing keywords surrounding STEM, such as science, technology, engineering, math, student success, persistence, and community college with Black students, African American, community college and URMS, was conducted using both the University of North Carolina at Charlotte (UNC Charlotte) library and Google Scholar. Both platforms provided a broad index of scholarly literature (i.e., books, reports, theses, peer-reviewed journal articles, and other documents) from a variety of databases. From this search, I set specific criteria for the studies to be considered. These criteria were:

- Peer-reviewed journal article or conference proceedings paper published from 2007- 2019
- Study participants included Black undergraduate engineering, math, technology, science students or STEM students, as the entire sample or a proportion of the sample as comparison groups
- Purpose of study focused on African American students majoring in STEM, African American community college students, successful transfer from the community college, community college student success in STEM, institutional climate and culture at the community college and STEM

- Credible Journal Sources like Educational Resources Information Center (ERIC), Education Research Complete (via EBSCO), and Academic Search (via EBSCO)

Figure 2.1 summarizes the studies presented in this review of the literature. Twenty-seven studies met the criteria. Figure 2.1 highlights the design, focus, theoretical framework, and factors that impacted STEM student success at community colleges and four-year institutions.

Citation	Methodology	Sample	Data Sources	Theoretical Framework(Cited	Factors[1]
Amelink & Meszaros (2011)	Mixed-Methods	Nine institutions with 1,629 students and faculty	Surveys; Interviews; Site visits; and Document Analysis	Student Retention	P,SS,CU,CL
Byars-Winston, Estrada, Howard, Davis, & Zalapa (2010)	Quantitative	Single University study including 223 science and engineering students	Surveys	Social Cognitive Career Theory	AI,SS,P
Casad, Petzel & Ingalls (2019)	Quantitative	579 U.S. undergraduate women students majoring in a STEM discipline	Surveys	Model of Threatening Academic Environments	P, SS, CU, CL, SC
Chang, Sharkness, Newman, & Hurtado, (2010)	Quantitative	3670 science and engineering students from 217 different institutions (about 45% URM)	Institutional Data	Student Persistence and degree attainment	AI, P, CU, CL
Dika, Pando, Tempest & Allen (2018)	Mixed Methods	24 Black and 17 Latinx university level junior and senior engineering students	Surveys Focus Group Interviews	Community Cultural Wealth	P,SS,CU

[1]CC = community college, P = persistence, SS = student success, AI = academic identity, CU = culture, CL = climate, SC = STEM culture

Figure 2.1: Factors Impacting STEM Student Success at Community Colleges and Four-year Institution

Citation	Methodology	Sample	Data Sources	Theoretical Framework Cited	Factors[1]
Fleming & Smith, (2013)	Mixed-Methods	200 Black and Latinx engineering students at four Minority Serving Institutions	Surveys; Semi-structured Interviews	Social Cognitive Theory	AI,P,CU,CL
Griffith (2010)	Quantitative	About 2000 STEM students	Institutional Data	Student Persistence	P, CL, SS
Hurtado, Cabrera, Lin, Arellano, & Espinosa, (2009)	Qualitative	65 URM STEM students	Site visits; Focus groups; and Document Analysis	Culture of STEM; Science Identity; and Self-efficacy	CU,CL,AI, SS,P
Jackson & Laanan, (2011)	Mixed Methods	Ninety-nine female CC transfer students in STEM majors	Survey Data; and Semi-structured Interviews	Classroom Climate; and Campus Dynamics	CC, CU, CL, SS, AI, SC, P
Lancaster & Xu (2017)	Qualitative	25 Black students in a university level STEM major	Focus Group Interviews	Tinto's Interactionalist Theory	AI, P, CU, CL, SS, SC

[1]CC = community college, P = persistence, SS = student success, AI = academic identity, CU = culture, CL = climate, SC = STEM culture

Figure 2.1: Factors Impacting STEM Student Success at Community Colleges and Four-year Institutions (continued)

Citation	Methodology	Sample	Data Sources	Theoretical Framework Cited	Factors[1]
Lord, Camcho, Layton, Long, Ohland & Washburn (2011)	Quantitative	79,417 STEM students at nine institutions; 18% were identified as URM groups	Institutional Data	Student Persistence; Social Outcomes	P,CU,CL ,SS
McGee & Martin (2011)	Qualitative	23 high-achieving Black math and engineering students	Surveys; and Semi-structured Interviews	Stereotype Threat	AI, CL,CU,S S,P
Newman (2011)	Qualitative	12 Black Engineering Students	Interviews; and Surveys	Fiske's Social Relational Model Student Persistence	CL, CU, SS, P
Nix & Perez-Felkner (2019)	Quantitative	Education Longitudinal Study (ELS) 2002/2012 Postsecondary Education Transcript Study(PETS)	Data Mining	Monte Carlo Chained Equation Method	AI, P, SS
Ohland, et al. (2008)	Quantitative	143,160 STEM students (MIDFIELD and APS DATA)	Institutional Data	Astin's Input Environment Outcome Model; Student Persistence	CU, CL, SS, AI, SC, P

[1]CC = community college, P = persistence, SS = student success, AI = academic identity, CU = culture, CL = climate, SC = STEM culture

Figure 2.1: Factors Impacting STEM Student Success at Community Colleges and Four-year Institutions (continued)

Citation	Methodology	Sample	Data Sources	Theoretical Framework Cited	Factors[1]
Ohland et al. (2011)	Quantitative	75,000 engineering students at nine Universities (MIDFIELD DATA)	Institutional Data	Student Persistence; Degree Attainment	CU, CL, SS, AI, SC, P
Packard, Gagnon, LaBelle, Jeffers, & Lynn (2011)	Qualitative	Thirty female students aged eighteen to forty-three, and 23% were ethnic minority students (five Black, one Asian, one Latina).	Individual semi-structured interviews	Savicka's (2005) Career Construction Theory; Bourdieu's (1986) Theory of Cultural Capital	CC,P,SS, CU,CL
Packard, Gagnon, & Senas, (2012)	Mixed Methods	172 full-time and part-time students from community colleges in Massachusetts	Survey Data/Semi-structured interviews	Social Ecology	CC,P,SS, CU,CL
Rainey, Dancy, Mickelson, Stearns & Moller (2018)	Mixed Method	201 College Seniors who were majoring in STEM fields or had declared a STEM major and left it for a non-STEM field	Roots of STEM Success Project	Intersectionality approach	AI,CU,SS,P, SC

[1]CC = community college, P = persistence, SS = student success, AI = academic identity, CU = culture, CL = climate, SC = STEM culture

Figure 2.1: Factors Impacting STEM Student Success at Community Colleges and Four-year Institutions (continued)

Citation	Methodology	Sample	Data Sources	Theoretical Framework Cited	Factors[1]
Reyes (2011)	Qualitative	Nine female students	Two one hour semi-structured interviews	Transfer Shock and Isolation; Social Networks and Social Capital	CC, P, SS, CU, CL
Sharkness, Eagan Jr, Hurtado, Figueroa, & Chang, (2010)	Quantitative	4,122 STEM students attending 224 institutions; Combined almost 50% of the population were Black and Latinx	Institutional Data	Student College Outcomes; Degree Completion	CU, CL, SS, SC, P
Starobin & Laanan, (2008)	Literature Review; Three females interviews	Qualitative	Literature Review; Interviews	Student Persistence	CU, CL, SS, SC, P
Vogt (2008)	Quantitative	713 engineering students at four Universities	Surveys	Bandura's Social Cognitive Model	CL,SS,P

[1]CC = community college, P = persistence, SS = student success, AI = academic identity, CU = culture, CL = climate, SC = STEM culture

Figure 2.1: Factors Impacting STEM Student Success at Community Colleges and Four-year Institutions (continued)

Citation	Methodology	Sample	Data Sources	Theoretical Framework(s) Cited	Factors[1]
Wang (2015)	Quantitative	Beginning Postsecondary Students Longitudinal Study (BPS:04/09) and (PETS:09)	Data Mining	Bahr's (2013) Deconstructive Framework	CC,P,SS,CU,CL
Wang (2017)	Quantitative	Beginning Postsecondary Students Longitudinal Study (BPS:04/09) and (PETS:09)	Data Mining	Momentum for Community College Student Success Framework	CC,P,SS,CL
Williamson (2010)	Mixed Methods	99 Black male STEM college students	Surveys Interviews	Cultural-Ecological Theory of Minority Student Performance	AI, P, CU, CL, SS
Zeledón-Pérezsan (2019)	Quantitative	Beginning Postsecondary Students Longitudinal Study (BPS:04/09)	Data Mining	Stanton-Salazar's Social Capital Framework & Pascarella's (1985) General Model for Assessing Change	CC,CU,SS, P

[1]CC = community college, P = persistence, SS = student success, AI = academic identity, CU = culture, CL = climate, SC = STEM culture

Figure 2.1: Factors Impacting STEM Student Success at Community Colleges and Four-year Institutions (continued)

All twenty-seven studies included in this review of the factors impacting STEM student success at community colleges and four-year institutions linked student success

and persistence of students in STEM with the culture and climate of the institution. Seven of these studies were explicitly examining community college students and their persistence in STEM (Jackson & Laanan, 2011; Packard et al., 2011, ; Reyes, 2011; Wang, 2015, 2017). The other twenty studies looked at student persistence in STEM at four-year universities. Because my study examined community college students who have transferred to the four-year school and majored in STEM, these twenty studies that focused on student persistence of STEM students at four-year universities were included in this review of the literature. Twelve of these studies linked academic/STEM identity to student success and persistence of URMs and women: (Byars-Winston et al., 2010; Chang et al., 2010; Fleming & Smith, 2013; Hurtado et al., 2009; Jackson & Laanan, 2011; Lancaster & Xu, 2018; McGee & Martin, 2011; Nix & Perez-Felkner, 2019; Ohland et al., 2011, 2008; Rainey et al., 2018; Williamson, 2010), one of which included data from community college students (Jackson & Laanan, 2011). Five of the studies also linked the culture of STEM to student success: (Jackson & Laanan, 2011; Ohland et al., 2011, 2008; Sharkness et al., 2010; Starobin & Laanan, 2008). A more thorough review of these studies isprovided in the following sections.

URM STEM Success at the Community College

The following studies included research on community college STEM student success for URMs. Packard, Gagnon, Labelle, Jeffers and Lynn (2011) examined women's experiences in the community college transfer pathway as they pursued baccalaureate degrees in STEM fields. In this study, they interviewed 30 women who planned to transfer to a four-year school and major in STEM. Five of these women identified as African American, one Asian, one Latina, and twenty-three White. The

findings were not disaggregated by race. Packard et al. found that the women, who planned to transfer to a four-year university and major in STEM, experienced the following stressors, barriers and influencers, while at the community college: (a) inspiring professors, who encouraged STEM pursuit; (b) gratefulness for peer academic support; (c) appreciation for helpful transfer advising; (d) value of family support; (e) flexibility in work schedules, which facilitated college-going; (f) delays from ineffective initial advising; and (g) limited finances.

Out of the thirty women that were interviewed for this study, a total of twenty-two women transitioned to a four-year university. Packard et al. (2011) found post-transfer experiences were impacted by: (a) negative course experiences, (b) poor experiences with four-year advisors, (c) unwelcoming campuses, (d) financial pressures and work challenges, (e) shifting fields, (f) finding a helpful professor or advisor, and (g) access to co-transfer support. Each influenced persistence and feelings of belonging. In a similar study, Reyes (2011) interviewed Futurebound scholars, a summer bridge program for women that had transferred from the community college to the University of Arizona who planned to major in STEM. Nine students were interviewed with four students being women of color. This study found that the grueling transfer process, differences in institutional cultures, academic expectations, isolation and invisibility, lack of social network, and managing conflict, priorities and expectations were experiences that impacted the students as they transferred to a four-year school. One of the major recommendations of this study was to implement first-year programs for community college transfer students to offset these experiences.

Jackson and Lanaan (2011) found that transfer student orientations, assistance from advisors, and getting involved on campus increased student persistence. Packard et al. (2012) found that informational setbacks were barriers to success. Informational setbacks were described as inadequate advising, lack of accurate financial aid information, imperfect program alignment and the community college's lack of resources.

In another study that examined URMs in the community college, Wang (2015) found that students beginning at community colleges were less likely to achieve STEM baccalaureate success. However, this adverse outcome was reduced, if the students were successful in their STEM classes, during their first term affirming their ability to do STEM coursework. In a later study, Wang (2016) utilized data mining to examine course and program features that contribute to efficient and effective academic STEM pathways for community college students. Utilizing the Beginning Postsecondary Students Longitudinal Study (BPS:04/09) and the Postsecondary Education Transcript Study (PETS:09) with 709,399 students, Wang found that only 4.4 % transferred into 4-year STEM programs, 55.3 % were male students and 44.7 % were females. Wang (2016) also found that relative to their share in the total sample (28.9 %), underrepresented minority students reported a lower percentage of transfer outcomes in both STEM (19.0 %) and non-STEM areas (24.3%). Similar disparities were observed with students who were single-parents, first-generation, non-traditional age, or with low high school GPAs. They were less likely to transfer upward into STEM or other areas of study. In another study utilizing the same data, Wang, Lee and Prevost (2017) furthered their research on URM community college students by examining the aspirational momentum of community

college students and the role it played in student persistence. Wang et al. (2017) found that transfer service usage was a significant predictor of maintaining an aspirational momentum related to the upward transfer in STEM. Additionally, when compared with White students, Black students' aspirational momentum was more positively related to transfer service usage.

Zeledón-Pérezsan (2019) utilized quantitative data to focus on the factors that influenced or hindered the frequency of interactions between faculty and advisors for STEM students of color at the community college. The author concluded that the more STEM students of color participated in study groups, attended fine art activities, and participated in sports and/or clubs, the more likely they interacted frequently with institutional agents. The findings also highlighted the importance of community engagement, relationships, and community experiences for students of color at the community college.

In a review of the literature, Packard, Gagnon, and Senas (2012) identified some of the barriers for community college STEM students. These barriers, included: limited knowledge of how to navigate the college atmosphere; financial barriers; academic preparation in math and science; misalignment of core courses across community colleges and four-year schools; inconsistent advising; troubles with academic and social integration; self-doubt; and limited sustainability of programs designed to improve retention. To offset these barriers, Packard et al. (2012) suggested outreach efforts that educated students and families about the pathways and opportunities within STEM fields, including the partnerships that existed among high schools, community colleges, and

four-year institutions; more recruitment efforts through the expansion of dual enrollment programs; and stronger mentoring programs.

Many studies examining the success and persistence of URMs transferring from the community college in STEM focused on college resources, environment, preparation, and transfer process as influential factors on student success and persistence. Likewise, URMs in STEM faced another set of barriers once they transferred to the four-year university. Research on URMs that persist in STEM cited institutional climate, the culture of STEM and STEM identity as the most important factors impacting the success and persistence of URMS in STEM.

Perception of Institutional Climate for STEM Students at 4-Year Universities

There were a variety of studies that focused on how institutional climate impacted STEM student success. Institutional climate, according to Allen-Ramdial and Campbell (2014) impacted the institutional culture and helped shape the environment in which diverse students learned and practiced. Institutional culture represented the collection of shared values and beliefs, a blueprint that guided actions, which inevitably established climate. Institutional climate represented the practices and behaviors that determined the prevailing attitudes in the environment (Allen-Ramdial & Campbell, 2014). Research shows that institutional climate heavily impacted a student's sense of belonging. Cress and Sax (1998) found that climate and culture could have positive effects on persistence and student success.

Camacho et al. (2010) investigated how the perceptions of "climate" for undergraduate engineering programs varied for underrepresented groups and had changed

over time. A survey explored issues related to how students perceived competitiveness, unfairness, and their sense of belongingness at their university. This study, designed as a longitudinal study, measured these student perceptions over time. The authors found that the students' perception of the institutional climate had improved. However, women scored the climate as having lower attributes of fairness, inclusion in study groups, and diversity than men.

In another study, Vogt (2008) explored environmental effects on student persistence and found that faculty distance lowered self-efficacy, academic confidence, and GPA. In addition to pre-college preparation, components of institutional climate such as, student engagement, institutional satisfaction, family and peer support, mentor and advisor relationships, and institutional support were important factors for college student's success in the STEM fields (Amelink & Meszaros, 2011; Camacho et al., 2010; Newman, 2011; Vogt, 2008). Newman (2011) highlighted the importance of faculty relationships in the persistence of African American students in engineering and their role in encouraging or prohibiting students to persist in their respective degrees. Involvement in faculty research, the presence of faculty role models, and the application of coursework to career goals encouraged African American students to persist.

In a study examining institutional factors on STEM persistence, Berger and Milem (2000) found that institutional structural-demographic characteristics (e.g., institutional size, control [private vs. public], selectivity, institution type, and location [rural vs. urban]) influenced student outcomes. The model they proposed asserted that student experiences were composed of the social, academic, and functional aspects.

Ambrose, Bridges, Lovett, DiPietro, and Norman (2010) explored the classroom climate and defined it as:

> The intellectual, social, emotional, and physical environments in which our students learn. Climate is determined by a constellation of interacting factors that include faculty-student interaction, the tone instructors set, instances of stereotyping, the course demographics (for example, relative size of racial and other social groups enrolled in the course), student-student interaction, and the range of perspectives represented in the course content and materials. (Ambrose et al., 2010, p. 170)

Consequently, the research also showed that the lack of diversity in STEM programs resulted in environments described as more hostile for students of color because of limited interactions with faculty and peers (Cole & Espinoza, 2008; McGee & Martin, 2011).

Culture of STEM

Many researchers have explored and defined the culture of STEM as a factor that impacts STEM persistence. According to Tierney (2008), "culture pertains to the norms values and ideologies that are created, shaped and sustained in an organization" (p. 27). In STEM education, the culture has been described as the explicit and implicit customs and behaviors, norms, and values that are normative within STEM education (National Research Council, 2009). The National Academies of Sciences (2016) further defined it as, "the shared patterns of norms, behaviors, and values of STEM disciplines that manifest themselves in the way courses are taught, and the classroom is experienced" (p.

60). The National Academies of Sciences, described STEM culture as having a major impact on students' interest, self-concept, sense of connectedness, and persistence.

STEM culture in higher education has been identified by several characteristics in STEM research that included competitive atmospheres, unwelcoming environments, lecture styled teaching, and specific STEM vernacular that perpetuated White masculine norms. In Bok's, (2009) analysis of undergraduate education, one problem identified was the design of the introductory science courses. Bok argued that the design of the courses and the competitive atmosphere encouraged in the courses served as a filter to weed out less desirable students. The atmosphere created in these classes was unwelcoming to students and many students who could benefit from studying science and mathematics chose to transfer into other academic fields (National Research Council, 2009). The culture of STEM was described as being shaped by heavily lecture styled courses, and with a significant proportion of STEM faculty receiving little to no training in effective teaching techniques (Anderson et al., 2011; Brownell & Tanner, 2012; National Academies of Sciences, Engineering, and Medicine, 2016; National Research Council, 2009). This resulted in STEM classes being heavily lecture-based, encouraging students to be passive learners.

The National Academies of Science (2016) identified specific barriers from STEM culture for underrepresented minorities. These barriers included the notion that:

- STEM success is naturally inherent, which means that being good at STEM is something that people are born with and cannot be learned (Crisp, Nora, & Taggart, 2009; Dai & Cromley, 2014; Smith, Lewis, Hawthorne, & Hodges, 2013);

- Discursive norms in STEM classrooms around debate and argumentation with student peers and instructors may not reflect students' own prior experiences and norms in their communities and schools. For example, learned classroom dynamics in some cultures are not acceptable such as argumentation with an elder (Brown, 2004; Kurth, Anderson, & Palincsar, 2002); and
- The language of STEM reflecting White, middle-class, masculine norms, with complicated language identifying members from nonmembers (Brandt, 2008; Lemke, 2001; Olitsky, 2007).

URMs that persist also must counteract stereotypes embedded in organizational norms and practices with their personal, cultural, and co-curricular resources. Research has shown that URMs face stigmatizing experiences in the forms of discrimination, microaggressions, and limiting stereotypes. The term microaggression has been used to describe subtle or overt statements and behaviors that intentionally or unintentionally communicate devaluing messages about a group (Chang, Eagan, Lin, & Hurtado, 2011; Fries-Britt & Griffin, 2007; Yosso, Smith, Ceja, & Solórzano, 2009). Research has shown that this leads to feelings of invisibility, as the individual was only viewed by the stereotype with which they were associated. Franklin and Boyd-Franklin (2000) coined this phenomenon as invisibility syndrome. Similarly, URMs also were impacted by stereotype threat (STT), which Steele and Aronson (1995) defined as being a risk of confirming, as a self-characteristic, a negative stereotype about one's social group. STT has shown to impact the performance of an academic task negatively (Aronson & Salinas, 1997; McKay, Doverspike, Bowen-Hilton, & Martin, 2002; Steele & Aronson, 1995).

While STEM culture has been influenced by the barriers discussed, colleges and universities have the opportunity to create a fostering culture within their STEM departments. Models of interactive learning and exploration have been implemented in primary and secondary classrooms to encourage STEM interest (Hayden, Ouyang, Scinski, Olszewski, & Bielefeldt, 2011). It is important to keep exploring this in higher education because students' interest, self-concept, sense of connectedness, and persistence are impacted by a school's STEM culture (National Academies of Science, 2016). This consequently helps them create their academic identity, which heavily influences their STEM identity and their student success in STEM.

STEM Identity

Research has shown how the culture of an environment impacted academic identity and persistence (Chang et al., 2011; National Research Council, 2009), and STEM persistence was associated with a student's ability to identify with STEM and STEM careers (Carlone & Johnson, 2007; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). As the identity lens was utilized to explore STEM persistence, it offered a unique understanding of student's alienation or recruitment in STEM fields (Carlone & Johnson, 2007; Kozoll & Osborne, 2004). Erickson (1963) coined identity formation as the process throughout each person's life, including the experiences of different crises or conflicts that impacted how they formed their identity. A person who integrated their prior experiences and characteristics with their physical growth, sexual maturation, and impending career choices achieved a stable identity (Erikson, 1994).

Marcia (1993) extended Erikson's work and named four identity statuses in which an individual may reside in the process of identity development:

- Identity foreclosure - refers to adopting the goals, values, and lifestyle that significant others have prescribed for an individual;
- Identity diffusion - when an individual has not experienced either a crisis nor has he/she committed to a set of values, goals, or beliefs;
- Identity moratorium - the gradual exploration of personal and occupational choices. This is a time of instability regarding values, goals, and beliefs, reflecting the experience of a crisis, without the resulting commitment;
- Identity achievement - when one has critically analyzed values in comparison to their self-view and made choices to pursue certain options. These individuals have experienced both crisis and commitment.

Hawkins (2005) defined identity formation as, "an ongoing negotiation between the individual and the social context or environment, with particular attention paid to operant cultural and power relations," (p. 61). Hawkins suggested that identities continuously formed through social interaction. Specifically, identity formation in school settings evolved from the interactive social environment in which learning occurred. Reveles, Cordova, and Kelly (2004) explained, "Within a classroom context, individual and collective identities are constructed through specific classroom discourse and activity as teachers and students interactionally define the cultural knowledge of schooling" (p. 1140). They asserted that students' perceptions of self were altered over time to meet the demands and expectations of their teachers and fellow students.

One of the foundational theories on the identity formation of college students was Chickering's (1969) Theory of Identity Development. Chickering developed this theory in 1969, but later revamped it with Linda Reisser in 1993. Essentially, Chickering's

theory identified seven “vectors” of development which included developing competence, managing emotions, moving through autonomy toward interdependence, developing mature interpersonal relationships, establishing identity, and developing purpose and integrity (Chickering & Reisser, 1993). In this theory, the vectors influenced and built on each other with the process of development described as being fluid in nature based off the student’s environment and interactions over time.

Reveles et al. (2004) made the comparison between academic identity formation and self-efficacy in which they similarly measured how a student perceived him or herself as being capable of completing academic tasks. Other quantitative studies measured or defined academic identity by the constructs of future orientation, self-efficacy, confidence in academic abilities, and grit (DeCandia, 2014). Was and Isaacson (2009) defined academic identity status as one’s view of oneself in an academic setup as informed by one’s choices and commitment to school roles, values, and goals. These concepts are utilized in many studies examining academic identity statuses (Fearon, 2012; Hejazi, Lavasani, Amani, & Was, 2012; Was, Al-Harthy, Stack-Oden, & Isaacson, 2009).

As the literature on identity formation grew, theories of identity formation applicable to individuals from ethnic or cultural minority groups developed. In a study conducted by Phinney and Ong (2007), they explained how, “like a personal identity, an ethnic identity refers to a sense of self, but it differs in that it involves a shared sense of identity with others who belong to the same ethnic group” (p. 275). Ultimately, when a person has multiple identities, the intersectionality of these identities must be considered. Some research has shown that ethnic identity and academic identity were incompatible

for some minority students. Specifically, some argued that academic success was achieved at the expense of a positive sense of racial-ethnic identity (Conchas, 2006; Kunjufu, 1995; Noguera & Wing, 2006). Other studies, (Flores, 2011; Whitesell, Mitchell, Spicer, & Voices of Indian Teens Project Team, 2009) found that if the ethnic or cultural identity was nourished positively with a student's academic success, it promoted student success. The concept of identity encompasses one's past, present and future experiences along with one's ethnicity, race, religion, gender, sexual orientation, life-histories, and current realities; therefore, indicating that people have multiple identities (Alsup, 2006; Gee, 2000).

This current study sought to explore STEM identity. As STEM stands for science, technology, engineering, and math, many research studies examined each identity separately. For example, previous research defined mathematical identity as a construct that looked at the individual's beliefs, attitudes and feelings towards mathematics (Boaler, 2002; Cribbs, Hazari, Sonnert, & Sadler, 2015; Edwards, 2010). This identity described students' abilities to perform mathematics and experienced learning mathematics as a process. Similarly, engineering identity focused on whether a student can consider or view themselves as an engineers and the culture and qualities that students perceived as important to become an engineer (Capobianco, French, & Diefes-Du, 2012; Matusovich, Barry, Meyers, & Louis, 2011; Tonso, 2006).

STEM identity was a term operationalized by Herrera, Hurtado, Garcia, and Gasiewski, (2012) as a theoretical framework. It built off of Carlone and Johnson's (2007) original conception of science identity which was categorized by competence, performance, and recognition. In Carlone and Johnson's study, a strong STEM identity

related to an individual that was competent or able to demonstrate skills and science knowledge through performance and recognized as having this knowledge in STEM. Carlone and Johnson highlighted the importance of a student recognizing themselves as a scientist, and recognized by others as a legitimate science person. This implied that their conception of science identity was heavily dependent on social interactions which supported Syed, Azmitia, and Cooper's (2011) finding that social support was strongly related to identity development, as different support figures served as identity agents. In their study, a student's ability to identify with science and a science career resulted in science persistence.

Herrera, Hurtado, Garcia, and Gasiewski (2012) focused on the intersectionalities of a student's personal identity with their STEM identity. According to Jones and McEwen (2000), one's core identity was conceptualized through intersection identity dimensions like race, ethnicity, gender, sexual orientation and religion and defined in relation to other dimensions. Herrera, et al. (2012) highlighted three contexts in their STEM identity model which included societal contexts, non-STEM contexts, and STEM contexts.

Within a societal context, social structures were viewed through the use of intersectionality, which referred to the embedded inequalities assumed in analyses related to race, gender, and class (Crenshaw, 1997). The underrepresentation of women and specific minority groups in STEM fields was reflective of the power systems and social inequities that perpetuated the societal structure of the United States. Research shows that this was evident in the K-12 schools as African American, American Indian, and Latinx students attended schools with fewer resources and opportunities to develop the

solid academic base necessary for a science career (Cooper & Burciaga, 2011). STEM context referred to the norms and historically constructed meanings associated with the discipline and non-STEM context was everything else. According to Johnson, Brown, Carlone, and Cuevas, (2011), STEM contexts were held at higher status arenas. STEM identity developed through reflections of how one perceived, positioned, and aligned oneself within STEM contexts, and how they were perceived and recognized by others (Herrera, Hurtado, Garcia, & Gasiewski, 2012).

Ultimately, research defined STEM identity as a student's ability to perform well in STEM subject areas, identify with STEM careers, and socially connect with people in the STEM field. STEM identity was heavily influenced by a student's perception of themselves and how they fit within their environment due to their experiences and beliefs about STEM. The term STEM, academic, math and science identity appeared in multiple studies highlighting its importance in STEM persistence, especially for URM students in STEM.

CHAPTER 3: METHODOLOGY

The purpose of this study was to explore how African American community college transfer students, who majored in STEM, developed a STEM identity, and how these students' educational experiences influenced the development of STEM identity for STEM persisters. Chapter 2 provided an examination of the extant literature presented the key concepts including student persistence and retention theories and their relation to post-secondary student success and the success of community colleges with underrepresented minority groups in STEM. Chapter 3 will describe and overview of the current study's context, research design, and data analysis.

Research Questions

The research questions that guided this study:

1. What educational experiences do African American community college transfer students majoring in STEM at the university level perceive as most important to their persistence in STEM?
2. How do African American community college transfer students develop their STEM identity?
3. How have the educational experiences of African American community college transfer students influenced the development of their STEM identity?
4. How does race influence the development of STEM identity in African American community college transfer students?

The Roots of STEM Study

This current study was derived from a larger National Science Foundation supported project (DRL 14-20363) titled *The Community College Roots of STEM: Interactive influence of individual, secondary school, and college factors predicting the success of underrepresented groups*, awarded to Dr. Stearns, Dr. Bottia, Dr. Mickelson, Dr. Allen, Dr. Moller, and Dr. Dancy in 2015. The grant was divided into several phases with the first utilizing qualitative inquiry to investigate factors that contributed to STEM success and failure for underrepresented minorities at the 16 campuses of the University of North Carolina System who utilized the community college in their educational pathway. I joined the team in 2015 serving in the capacity of a Graduate Research Assistant. During phase I of the study, we interviewed students enrolled at community colleges in North Carolina who intended to transfer to a 4-year school and major in a STEM field.

The participants during Phase I of the Roots of STEM study were interviewed if they met the following criteria:

- Currently enrolled at a North Carolina community college
- Intended to transfer to a four-school and major in a STEM field

The interview protocol was designed and piloted by the Roots of STEM research team. The questions were developed through an in-depth review of the literature and feedback from experts in the field. The interview protocol gathered information about the student's educational experiences that occurred during high school, at the community college, and in their university math and science courses. These questions explored topics such as the learning environments of the students, student self-efficacy, how students

identified with STEM, experiences of a URM in STEM, and how they experienced the climate and culture of their respective STEM field.

During the Spring of 2018, the Roots of STEM research team launched the 2nd Phase of this project, in which we followed up and interviewed students who participated in Phase I of the Roots of STEM project. Some of the students from Phase I of the Roots of STEM project were still attending community college or were out of formal education altogether. For those reasons the Community College Roots of STEM team supplemented their sample of interviewees with 37 interviews with students who had attended a community college, transferred to a four-year university and were majoring in STEM fields. We interviewed students if they met one of the following criteria:

- Were interviewed during Phase I of the Roots of STEM project, or were
- A student who transferred from a North Carolina community college and was majoring in STEM

This additional set of students were a targeted effort in which the students were primarily recruited through the Research Study Announcement mechanism at one North Carolina University, as well as through snowball interviews. Purposive sampling, utilizing the snowball sampling technique, was used. According to Cohen and Arieli (2011) a purposive sample is a sample that is selected based on the characteristics of a population and the objective of the study. This type of sampling is known to be appropriate when a researcher needs information-rich data from a specific population (Patton, 2002). Recruitment emails (Appendix A) were sent to students who participated in phase I of the Roots of STEM project, and to students who had been referred by a colleague, fellow student or professor as meeting the criteria of a project participant.

Because the Roots of STEM team looked at a specific population, this type of purposive sampling was used, and since the research team relied on the referrals of other participants to recruit students for the study, the snowball sampling technique was also appropriate. Snowball sampling is a technique used for gathering research subjects through the identification of an initial subject which is used to provide the names of other study participants (Lewis-Beck, Bryman, & Liao, 2003). It was an effective way to recruit participants for the study when looking at this unique population.

The data for the Roots of STEM study was collected from the interviews of students that attended a community college, matriculated to one of the sixteen UNC system schools and majored in STEM. The Roots of STEM research team chose to collect data from North Carolina because of its diverse population:African Americans (22.2 %), Native Americans (1.9%), Asians (2.9%), and Whites (71.9%) (US Census Data, 2016). The UNC system is composed of sixteen campuses, which include five historically Black colleges and universities and one campus that historically served primarily American Indian students, UNC at Pembroke. My dissertation study was one of many subset projects drawn from this larger research agenda.

Dissertation Research Design

This dissertation study was a qualitative research study. According to Glaser and Strauss (2017), "a qualitative study is the most suited method to gain understanding about "structural conditions, norms, processes, patterns and systems" (p. 18). Qualitative research questions are designed to explore how people make meaning of their experiences and construct their realities in the world. According to Merriam and Tisdell (2015), the following characteristics are essential in understanding the nature of

qualitative research: the focus on process, understanding, and meaning; the researcher as the primary instrument of data collection and analysis; the process is inductive; and the product is richly descriptive. In the qualitative method, the investigator systematically collects data and analyzes it to draw insight and discernment from it. Qualitative inquiry focuses on meaning in context and requires a data collection instrument that is sensitive to underlying meaning when gathering and interpreting data (Merriam & Tisdell, 2015). Qualitative research design requires the investigator to do a critical analysis of the data and to recognize the tendency towards bias. The investigator should be open to the information that emerges and remain flexible (Strauss & Corbin, 1998). Qualitative research is a process of extrapolating a deep understanding of social phenomena through questioning, observing, or collecting data from participants in their natural environment.

The results of this study are not generalizable as that is not the purpose of this study. Qualitative studies are useful in providing a rich, contextualized understanding of human experience through the intensive study of particular cases (Polit & Beck, 2009). Seidman (2006) explains how in-depth qualitative research helps reveal higher-level concepts and theories that are not unique to a participant or setting. This study explores the depth of a phenomenon with a small sample size.

Methods

This qualitative study utilized interview data collected by the researcher. Merriam and Tisdell (2015) acknowledged, "In all forms of qualitative research, some and occasionally all of the data are collected through interviews" (p. 87). DeMarrais and Lapan (2003) defined an interview as, "a process in which a researcher and participant engage in a conversation focused on questions related to a research study" (p. 55).

Interviews allow the interviewer to pursue in-depth information on a topic. Interviews following a semi-structured format and conducted face-to-face, via Skype or phone can be used when the researcher has a specific topic to learn about, prepares a limited number of questions in advance and plans to ask follow-up questions (Rubin & Rubin, 2011).This method is particularly useful for getting the story behind a participant's experiences. This current study focused on the stories of the participants because it is rooted in CRT. In addition, employing a model that involved counter-storytelling, interviewing was an appropriate method for gathering data (Solórzano & Yosso, 2002).

There are, however, some limitations in qualitative interviewing. According to Creswell (2014), limitations in qualitative interviewing include: (a) information is presented through the perceptions of the participants; (b) information is collected in a prearranged place rather than in a natural field setting; (c) researcher's presence possibly biased the responses; and (d) all participants may not be equally articulate and perceptive. The purpose and benefits of qualitative interviewing outweigh its limitations for this research study.

Data Collection and Analysis

Participants were selected for this study if they satisfied the following criteria:

- Transferred to a four-year college or University in North Carolina from a community college and majored in STEM; and
- Identified as African American and Black.

An IRB was approved on April 17, 2018 to utilize the data collected during Phase II of the Roots of STEM research project in this dissertation study. This approval also granted

a revision to the Roots of STEM interview protocol (Appendix A) to include interview questions about STEM identity.

For recruitment, on behalf of the Roots of STEM research team, I emailed students who: participated in Phase I of the Roots of STEM research project, identified as African American, and had plans to transfer to a four-year university after their time at the community college. From this group, I invited sixteen students to participate in Phase II of the project. Informed consent was obtained prior to each interview. The interviews varied in times from the shortest interview being completed in forty minutes and the longest interview lasting a little over an hour and a half. From these interviews only six of those were used in this study because only six of those students successfully transferred to a four-year university and declared a STEM major.

From this group, I phone-interviewed three more students who identified as African American, declared a STEM major at a university, and had previously transferred from a community college. The last interview was conducted in-person by one of the Roots of STEM research team members. All interviews were audio recorded and transcribed by a paid transcription service. The interviews of the first ten students, who met the criteria for the dissertation study, were analyzed.

Although the interviews were transcribed by a paid transcription service, I listened to each interview three times, and took notes. During the interviews, I let the students know that talking about their academic history could make them feel uncomfortable, but they had the option to stop the interview at any time or refuse to answer questions. Each participant was given a $25 Visa gift card for completing the interview.

For the ten interviews included in this study, I utilized thematic coding to analyze the data. Thematic coding is a method in which narratives from the interviewees are used to develop themes (Rubin & Rubin, 2011). The Sage Handbook of Qualitative Analysis defines thematic analysis as, "a data reduction and analysis strategy by which qualitative data are segmented, categorized, summarized, and reconstructed in a way that captures the important concepts within the data set" (Given, 2008, p. 26). Similarly, thematic coding is defined as a form of qualitative analysis which involves recording or identifying passages of text linked by a common theme or idea (Given, 2008). Patterns or themes were then identified and associated with the specific research questions. Interview responses were categorized according to themes and analyzed examining the frequency and distribution of concepts. Pseudonyms were assigned to the participants in this study to ensure privacy.

During the interview phase, I utilized member checking and memoing to ensure the trustworthiness of the data. Memoing is the process of writing notes or memos about thoughts related to the analysis of one's data (Birks, Chapman, & Francis, 2008). In research, memoing can aid in data exploration. Member checking was also utilized during the interview process. Member checking is a technique used to ensure the accuracy of the data (Birt, Scott, Cavers, Campbell, & Walter, 2016). After each interview question, I restated or summarized information and then questioned the participant to determine accuracy.

To ensure that the ethical considerations were met within the study, I let the participants know that participation in this study was voluntary. Informed consent was obtained from each participant in the study, informing them of the purpose of the study,

the protocol, and their rights as participants. The data collected was kept confidential and I respected the anonymity of the research participants. The data was stored in a secure place, removing all personally identifiable information, and utilizing pseudonyms for the participants' names. As a method of handling bias within this research, I acknowledged my biases to identify factors that could skew data interpretation. According to Creswell and Miller (2000), the researcher should consider self in relation to the topic of research to cope with bias.

Disclosure Statement

I am an African American female doctoral student in the Educational Leadership Program at one of the sixteen North Carolina Colleges and Universities. I also have a strong familial influence toward STEM and am sensitive to their experiences. During this study, I was aware of my identity and made sure my perceptions did not influence the interpretations of the findings.

CHAPTER 4: FINDINGS

This qualitative study explored how African American community college transfer student persisters, who majored in STEM, developed a STEM identity, and how students' educational experiences influence this identity development. This chapter begins with a description of the study's participants, and then continues with a discussion of the emergent themes from the data. Four research questions guided the study:

1. What educational experiences do African American community college transfer students majoring in STEM at the university level perceive as most important to their persistence in STEM?
2. How do African American community college transfer students develop their STEM identity?
3. How have the educational experiences of African American community college transfer students influenced the development of their STEM identity?
4. How does race influence the development of STEM identity in African American community college transfer students?

The following section provides profiles of the study's participants. According to Seidman (2006), constructing a participant profile or vignette is an effective way to introduce analysis and interpretation. Below are brief summaries of the participant's educational journeys. Figure 3.1 includes basic demographic data of each participant.

Study Participants

Name	Gender	Race	2-Year School	4-Year School	Major	# of Semesters left to Graduate
Stacy	Female	AA	Triangle Community College	State University	Biomedical Engineer	2
Eric	Male	AA	Triangle Community College	State University	Computer Science	3
Maya	Female	AA	Triangle Community College	State University	Earth and Environmental Sciences/minor in Computer Engineering	2
Lynette	Female	AA	Salt City Community College	State University	Math/ Secondary Ed. Minor	3
Joseph	Male	AA	Morning Tech	Historically Black University	Civil Engineering	2
Lauren	Female	AA	Morning Tech	ABC University	Biology/ Medical Anthropology	1 week
Ariel	Female	AA	Triangle Community College	State University	Computer Science	2
Jamie	Female	AA	Triangle Community College	Historically Black University	Agriculture Science/ Education	2
Tyler	Male	AA	Morning Tech	Engineering University	Dual: Computer Engineering/ Electrical Engineering	4
William	Male	AA	ABC Tech	State University	Mechanical Engineering	4

Figure 3.1: Participant Demographics

Stacy

At an early age, Stacy talked about her dreams of becoming a doctor because of her desire to help people. Once Stacy graduated from high school, she decided to begin her post-secondary education at the community college (TCC) and major in biology. While attending TCC, Stacy was invited to join a minority STEM organization on campus where she was introduced to Bioengineering. One year later, Stacy transferred to State University and is currently majoring in Biomedical Engineering. At the time of the interview, Stacy had two more semesters before graduation.

Eric

At the time of the interview, Eric was majoring in Computer Science with a concentration in Gaming, Artificial Intelligence (AI) and robotics. Eric's pathway to a STEM college major started in high school when he took dual enrollment courses with the local community college. Upon graduation from high school, Eric attended a prestigious state engineering university, but was only there for two semesters. He transferred out of Carolina University and attended the local community college to restore his GPA and planned to transfer to a university close to home. At the time of the interview, Eric was a senior and had three more semesters before graduation. He plans to create gaming software applications once he graduates.

Maya

Maya is an Earth and Environmental Science major with a minor in computer engineering. Upon graduating from high school, Maya enrolled at a four-year University as a chemistry major. Unfortunately, she did not take school seriously and the classes were much more difficult than she had anticipated. Determined to get her college degree,

she transferred to the local community college to improve her GPA by taking the core courses that she had failed at the university. After excelling at the community college for two years, she transferred back to the university still planning to major in chemistry. It was actually Maya's advisor that suggested that she major in Earth and Environmental Sciences instead of chemistry. During the interview, Maya had two semesters until degree completion.

Lynette

Lynette fell in love with math in the third grade under the tutelage of her third-grade teacher. This third-grade experience fueled her desire to become a math teacher. After high school, Lynette enrolled in the community college by default. She waited too late to register for the universities and had no other option than the community college. She completed her associates degree at the community college then took off one year before entering a four-year university. At the time of interview, Lynette had three more semesters before degree completion.

Joseph

Joseph knew, since his first year of high school, that he wanted to be an engineer. He just was not sure what kind. However, all that changed when he attended a career fair in the 11th grade and had the opportunity to meet a civil engineer that told him about the civil engineering profession. This conversation influenced Joseph's decision to major in Civil Engineering.

Once Joseph knew that he would be majoring in Civil Engineering, he selected a community college that had the reputation of having a strong engineering department. Unfortunately, Joseph had difficulties during his studies at that community college and

decided to transfer to a four-year Historically Black College and University (HBCU). At the time of the interview, he was majoring in civil engineering with two semesters left to degree completion.

Lauren

Lauren graduated from the community college with her Associate of Science and transferred to a state university with a prestigious biology program. She was admitted and declared a Biology major. The university had a specialized program for students who intended to transfer from the community college to the university. After three semesters as a biology major, she changed her major to Medical Anthropology with a minor in African American studies. At the time of the interview, Lauren was one week from graduation.

Ariel

Ariel was majoring in computer science at the university. Her interest in computers was sparked at an early age. Once Ariel graduated from high school, she attended the local community college. It was there that she realized how much math was in the computer engineering curriculum and decided to pursue computer science with an emphasis in cyber security. Ariel met many people who were in the Computer Science field and it was easy to talk to them. Once Ariel graduates she wants to work in Cybersecurity. At the time of the interview, Ariel had two semesters left until graduation.

Jamie

Jamie is majoring in Agriculture Science. She transferred from Triangle Community College to a Historically Black College and University (HBCU). When Jamie enrolled at the community college she wanted to get into general education, but

that program had been discontinued. She saw the horticulture technology program and thought it would be interesting because she had taken a horticulture class in high school. She enrolled in horticulture technology. This program was a part of the 2+2 program, meaning that you would do two years at community college, and then two years for your bachelors at an HBCU.

Once Jamie transferred from the community college, she enrolled in an online program at the university. Jamie had a unique experience of transferring from a STEM focus at the community college and pursuing a Agriculture Science bachelor's degree in an online program. Over the course of Jamie's program, her interest in science has truly been stimulating because she now has a deeper appreciation for plants and food production.

Tyler

Tyler transferred from the community college to a top ranked state engineering university. Tyler's interests in STEM intertwined with a variety of other childhood interests like art and music. Tyler's post-secondary choices were heavily influenced by his high school experiences. In high school, Tyler did not focus on school and his grades suffered, so he ended up taking general education courses at the local community college. While at the community college, Tyler took a course that introduced him to different engineering majors and professions. After transferring to the university, Tyler chose his major after deep self-reflection. He thought about the things that he liked to do when he was a child. He remembered his fascination with electricity and his love for computer games. The university he transferred to offered a program where he was able to dual

major in computer engineering and electrical engineering. At the time of the interview, Tyler was five semesters away from graduating.

William

William, intrigued by space at an early age, wanted to become an astronaut when he grew up. During a space museum visit, William was able to talk to someone about being an astronaut and they told him the easiest way to reach that goal was to become an engineer. William said that it was decided for him, by his uncle, that he would be going to the community college first before he pursued a degree at a university. Although William's initial interest in Mechanical Engineering stemmed from an early desire of space travel, he is now interested in Mechanical engineering for the money and employment opportunities. At the time of interview, William had four semesters to degree completion.

Thematic Data

The findings from this study were drawn from interviews with ten African American student participants, and although these findings are not generalizable, they weave together the experiences of the students to provide a more holistic understanding of the experiences. During analysis of the data, I categorized the students' experiences into three major themes. Figure 4.1 is a visual representation of these themes, which include: 'STEM is a Part of Who I Am', 'Breaking Through Barriers' and 'Even if I Am the Only One, I Have Support'. As the themes emerged from the student data, I realized they were interconnected and this relationship is captured in Figure 4.1. Within this figure, circular lines connect the themes, and they all contribute to the student's central goal of obtaining a bachelor's degree in a STEM field.

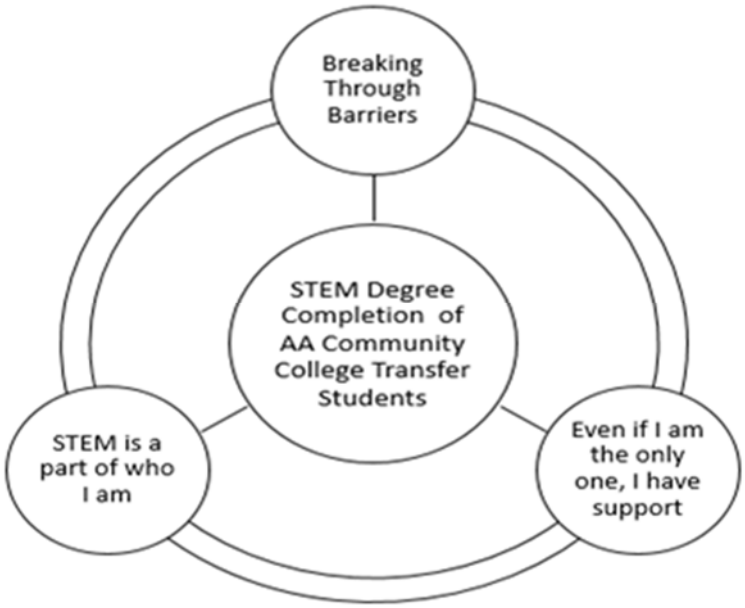

Figure 4.1: Major Themes

While barriers in STEM education for African American students is a highly researched topic, few studies delve deeper to examine how African American student persisters transferring from community colleges develop a STEM identity. Examining the role of the educational experiences of community college students provided insight into an understudied concept. The data from this study revealed unique findings about how these students overcame barriers and operationalized their support systems to situate themselves in their identities in STEM.

STEM is a Part of Who I Am: Developing a STEM Identity

When faced with roadblocks in STEM most of the students utilized their strong deep interest in STEM as encouragement to persist. The first theme in this study was,

"STEM is a Part of Who I Am: Developing a STEM Identity." This theme captures how the students described pre-collegiate experiences with STEM that solidified their connection to STEM. In the interviews with the students, their connection with STEM was described as a quality they were just born with, a way of thinking that they were naturally gifted at birth. As I listened to the students' stories, I realized that some childhood experience connected them to STEM so strongly that they describe it as a part of themselves. The first experience was early exposure to STEM, with the second being a higher aptitude for STEM learning in high school. The last behavior that was described by the students included a distinct method of problem-solving skills associated with a specific way of thinking, analytical problem solving mirrored after the scientific method.

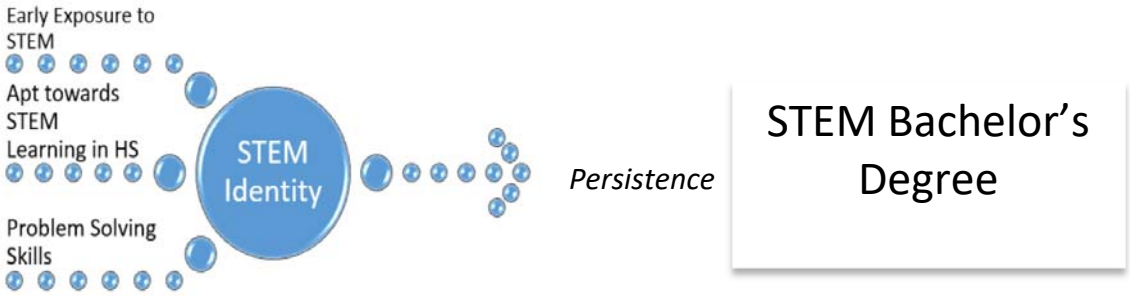

Figure 4.2 Contributors to STEM Identity

Early Exposure to STEM

The first element of the theme, "STEM is a Part of Who I Am," referred to an early exposure to STEM. Early exposure to STEM was defined by a positive experience with STEM-related content that occurred before the age of twelve. Seven out of the ten participants described the realization of their inclination towards STEM topics during their early years of schooling. For example, Maya talked about realizing her interest in STEM as early as elementary school.

> I always liked science I guess, even when I was in Elementary School. Everything that I always picked has been science related. So, chemistry was for sure what I wanted to do. When I was little, I wanted to be a doctor, and when I was in middle school, I wanted to be a tornado chaser. In high school was when I actually started to get in to physical sciences, like physics and chemistry. I ended up taking chemistry because I had great teachers that made it super fun.

Although Maya's interests changed over the years, her first interest of science, coupled with great science teachers, inspired her to major in STEM. Her interest and skill in STEM subjects were affirmed over the course of her life. Because of these affirmations, Maya was confident in her pathway to a STEM career. She said, "I would never major in History or English or anything, not because I think of them as any less, but I just don't have any interest in them. So, I have always considered myself a STEM student. Even in high school."

Similarly, three other students, Stacy, Eric and William described their interests in STEM starting at an early age. When Stacy was asked, during the interview, about when her interest in STEM began, she paused. "The first time? I don't know. I just grew up liking biology. I like helping people and I like biology, and I like science courses, so I thought it was perfect for me."

Eric's parents actually noticed his STEM interest at a young age. He explained,

> My secondary interests besides, you know, taking things apart was computers. I have always been interested in how they work. Ever since I was little, you know, whenever my parents would get a new one they would just let me have their old

> one and I would always, you know, try to figure out how it worked. My interest has since blossomed to the point where I've built my own gaming computer.

Although Eric's educational journey started at a four-year university where he majored in Mechanical Engineering, he faced academic barriers that forced him to switch his major. During this pivotal moment of Eric's educational journey, his family reminded him of his natural inclination toward computers and that encouraged him to major in something computer related because he was known for his expertise in computers. He explained,

> I've always been the person that my friends and family mainly came to whenever they had a little logical related issue. You know the computers that didn't turn on or their phones didn't turn on things like that. And I've always enjoyed, you know, figuring out back doors to things. I hate to say it but back when Apple first released iPods and iPhones and all of that when the whole jailbreaking and all of that was out. I love them. You know I would love to know how to put things on the phones that were supposedly there in the first place, you know….it was something that I always enjoy doing that I always felt accomplished after I was able to do it. You know, so they feel like you know it's a perfect fit for what I want, I've always been interested in.

Ariel, another Computer Science major, attributed her STEM aspirations to her childhood experiences, "When I was growing up, I had the asthma, and allergies so I couldn't go out that much...So, I kept to myself and played on the computer at home and taught myself to navigate around it." Lynette, another student, told her story of falling in love with math at an early age,

> When I was in third grade I had a great teacher, Miss Davis, who made me love math. We had a thing called Math measurement. And every time we'd do that, I would be in it out, I would get it fast. I used to get that multiplication, division and addition. Since then, I've loved math so much that I just want to teach the people to make it easier for them to understand….how she made me understand it easier to help people get further in life with math.

Three other students, Tyler, Lauren, and Joseph talked more about how their interest in STEM was developed because of a schooling event either at their high school or at the Community College. The students overwhelmingly attributed their interests in STEM to an early childhood experience in STEM that was cultivated in an educational setting.

Higher Aptitude for STEM learning in high school

The second element of STEM identity was characterized by a higher aptitude towards STEM learning in high school. A higher aptitude was associated with the students' performing better in high school STEM subjects than any other subjects. They described their experiences in STEM subject matter, as more enjoyable, and specifically mentioned an increased interest in STEM during their high school studies.

During their interviews, eight out of the ten students expressed an increased interest in STEM during their high school years. For example, Eric attended STEM related programs in both middle school and high school and graduated from an early college program. Eric attributed his choice of major to his attendance at that early college program he was a part of in high school. Maya specifically talked about how her high school experiences heavily influenced her interest in STEM. Maya made that connection

with STEM, “when I was in high school, I was in AP Chemistry and I took a really great interest in chemistry. So, when I first went to college, I was majoring in Chemistry.” Ultimately, Maya said the lab portion of her high school AP Chemistry was the most influential event that led her to her STEM major.

Lynette described the moment she knew she wanted to major in math during high school, and Joseph recalled his experience at a high school career fair and how it gave him direction of what STEM career he wanted to pursue.

> I always knew that I wanted to be an engineer, but I didn’t know what type of engineer that I wanted to be. I went to this career fair and there was a civil engineer there and basically it described what I wanted to do, like be outdoors and be with a team so I just fell in love with it.

Both Lauren and Ariel attributed their high school experience to reinforcing their career aspirations. For Lauren the most influential factor in her choosing to major in STEM was her high school biology teacher.

> I just remember the class being so much fun and really enjoying it. And also, my biology teacher at Morning Tech, liked making the class so much fun to learn about biology…. so I would say my teachers.

Ariel’s everyday high school experiences in STEM defined who she was in STEM. Ariel said she was always just better at math and science instead of English or writing when she was in the ninth grade. At first, she wanted to do software programming, because her best friend’s father was a software engineer. At that time, she thought she would do software engineering, but later decided on cyber security. Similarly, Tyler described himself as having a stronger background in science and math

in high school and then having a really great experience with a science teacher at the community college he attended. He referred to this teacher as the Morning Tech cheer coach.

All of the students included in this study described themselves as more inclined to STEM subjects in high school, even though they did not describe themselves as high performing students. These experiences led to their belief in their ability to do STEM especially in comparison to other subjects studied in high school. The students' early schooling experiences increased their belief in their ability to excel in STEM subjects, which supported the way they viewed themselves in STEM.

Problem Solving Skills

The last characterization of the theme, STEM is a Part of Who I Am, was the element of problem solving. Students described their connection with STEM as a way of thinking and how they solved problems. The type of problem solving that the students described was a methodological process that mirrored the scientific method of observation, measurement, and experiment.

Both Eric and Joseph connected their aptitude in STEM with their approach to problem solving. Eric explained,

> Whether it be course related or personal, I always sit down and just think about it as a math problem. You know what you know. You know what isn't known [sic] and how can I get from what I know to what I don't know. And how can I figure out those unknowns. So really a lot of times even in my personal life some people, they get upset at me because they're like well why are you thinking about it so black and white. And it's like, well that's my whole life-that I've been going

> to school. My whole life, that's how I've been thinking about everything, it's what I know. This is what I don't know. You know this is currently the only way I know how to figure out what I don't know. So, I've always had that kind of STEM thinking pattern, you know, the scientific method. This is what I know the hypothesis. Experiment on it, you know, look at the results. Maybe go back to my hypothesis, reevaluate it. So, I really do think of myself as a STEM person just simply because, I really try and think of things in a kind of a segmented way.

Joseph also explained the connection of STEM and his problem solving techniques. “Just because I like problem solving, I like figuring out the problems and stuff. I don’t know why, sometimes it irritates me but once you find out the answers, like, I feel relieved.” He also stated that he had won prizes for his problem solving capabilities. “Yeah like little engineering prizes at community college. I happened to calculate values that was actually difficult to calculate, projects, and stuff like that but yeah, like problem solving assignments.”

Lauren described this process as a way of thinking. When asked about her connection to how she viewed herself in STEM, she said, “I do think of myself still as a STEM person. Even though I have switched to the social sciences side. My process of going about things is still influenced by how you research things in biology so I would say yes.” During Lauren’s collegiate career, she changed her major to medical anthropology due to her negative experiences in her STEM courses at the four-year University. Despite this experience, she was still strongly connected to STEM.

Tyler said he had to rewire the way he solved problems to excel in engineering: “So, the math and learning process, I had to rewire how I approached the problem. You

know the engineer…You have a different way of thinking and approaching problems. It's hard to learn and it doesn't come naturally. It didn't come naturally to me. I guess, the learning process was the main deterrent." Being successful in engineering required recognizing the need for and developing a new way of approaching problems. As the students described themselves in connection to STEM, they assessed their way of thinking, and described a strong interest and aptitude in problem solving. They connected their identity in STEM to either the way they solved problems, or as a specific way of thinking that they had to adopt and learn to excel in STEM.

Breaking Through Barriers

'I am successful in spite of…..with Planning and Resilience'

The second theme that emerged from the data was Breaking Through Barriers. Imagine a glass door with a student on one side and a degree on the other. Although the student can see and desires a degree, they do not understand how to get past the glass door, which represented a barrier to entry. Research on community college transfer students in STEM highlights the barriers to entry in STEM for community college students such as: (a) limited knowledge of how to navigate the college atmosphere, (b) financial barriers, (c) academic preparation, and (d) misalignment of core courses across community colleges and four-year schools (Packard, Gagnon, & Senas, 2012). In this case, examining these barriers led to the discovery of this theme. Consistently across the interviews, the student data aligned with previous research on barriers to entry to STEM degrees for both community college students and African American students. Additionally, across all the interviews, the students gave details on how they overcame these barriers. Ultimately, the theme of breaking through barriers signifies the action of

the student finding a way to break through that glass door. In this study, the ways the students broke through the barriers were through two sub-themes that I have identified as (1) planning and (2) resilience.

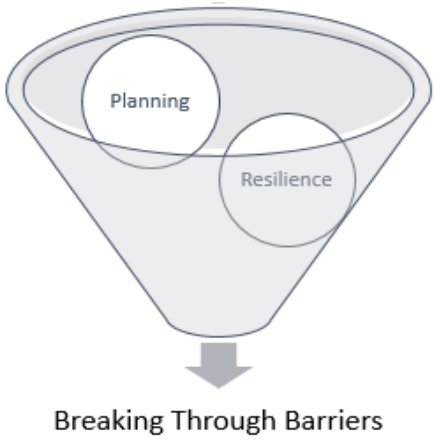

Figure 4.3. Breaking through Barriers subthemes

Planning

The students' strong desire to persist in STEM was driven by the connection established at an early age and the burgeoning of their STEM identity. In order to be successful, the data revealed that students (a) needed to be aware of the educational and financial commitments of obtaining a bachelor's degree and (b) needed to formulate a plan to meet those commitments. In this current study, I referred to the process of detailing a goal and designing specific action steps to achieve the goal as planning. Planning proved to be a critical aspect that contributed to student educational persistence, especially when met with a perceived barrier in their educational journey that needed to be overcome. Although students may not have used the word "planning" in their interviews, their stories detailed this process. Over the course of the interviews, students described the process of planning in regards to two areas: financial and educational

planning.

Financial Planning.

Finances are traditionally listed as a major barrier that limits the successful transfer and bachelor degree completion for community college students. During the interviews, students specifically named the community college as a strategy to overcome what they described as a "financial burden." For some students the financial planning process was described as the student gathering information on their schools of interest, and examining the cost of different pathways to that desired major. Before the students began their post-secondary educational journey, some of the students investigated the cost of post-secondary education to choose the most cost-effective route. In their analysis, they added up the costs of tuition and fees during their time of attendance at the community college.

Eight out of the ten students strategically planned to attend the community college because of financial reasons. During interviews, students named the community college as "affordable" or as Lynette described "a cheaper option." Lauren compared her experience to that of a student that only attended a university and talked about how she "saved so much money" by attending the community college first. The findings from this dissertation study revealed that one of the deciding factors to attend a community college was financial, which for some was a barrier to entry to post-secondary education.

Two of the students, Eric and Maya, actually started their post-secondary education at a four-year university, but later found themselves at the community college for a plethora of reasons. Both Eric and Maya talked about their financial struggles going straight from high school to the four-year university. It was not until Eric and Maya took

a step back and engaged in the financial planning process that they decided to transfer to a community college before transitioning again to four-year schools. According to Eric, this alleviated the full financial pressure of post-secondary education and gave him a way to continue his post-secondary education.

Attendance, at the community college was described, by the participants, as a strategic way to save money as they pursued a bachelor's degree. Ultimately, once the students engaged in financial planning, the information gathered was used as a tool to combat the financial barriers they faced in post-secondary education.

Educational Planning.

Educational planning was another type of "planning" that was a common theme amongst interviews. As described by the students, this process utilized a source of information to chart out the courses needed to transfer into their respective STEM majors. As opposed to the four-year university, students talked in terms of credits and classes, as opposed to years and classifications. Many of them were very aware of the time it would take them to graduate from the four-year university and what classes they needed to take at the community college in order to transfer. I attributed this to the planning process they endured during their educational journeys. In some cases, the advisors at both the community college and university helped the students map out their pathways once they decided their intended major.

For example, Stacy, the student who discovered biomedical engineering at the community college, talks about how much her advisor helped her create an academic plan. "They helped me a lot. They showed me the academic plans and how things go about in transferring and how your credits will be when transferring there at State

University." This was the case for many students. While Joseph was attending the community college, he toured the four-year school and received advice from a counselor that encouraged him to apply to the university. Initially, Joseph had gone to the university to make sure he was on track to transfer. During his educational planning phase, he found out he could already transfer to a four-year University.

Lauren, Jamie, Tyler and Ariel all talk about conversations they had with their community college advisors about their paths to a four-year university. At the beginning of each conversation, the advisor asked them about their intentions of transferring and intentionally showed them a plan on how to make this happen. Lauren explained the conversation as weird, but helpful.

> "So, it's weird how they did it at Morning Tech, when you go to your first advising they ask you if you are interested in transferring. I told them I was interested in psychology or biology. They bumped me up to the associates in science because the advisor was like it's always easier if you have too many credits than not have enough."

Lauren went further to talk about how knowledgeable the advisors were about the transfer process, and Jamie received a lot of information from her school's orientation classes. Similarly, during Tyler's orientation, he was introduced to STEM, and he also described his high school senior experience as one of educational planning,

> Straight out of high school, I knew I was going to Morning Tech so I didn't even take the SAT. I went to Morning Tech for two years. I planned on getting my associates. I was looking at colleges to transfer to, Carolina University. Data showed me that was the best choice in North Carolina. For me it was the most

> competitive …so, I wanted to enroll in that. I transferred to Carolina University. I applied and got in.

There were also students who navigated the systems by themselves without formal advisors or counselors, for example Eric said,

> I honestly really didn't use any. At least none physically on the college's campus. They did have a TCC fee transfer catalog which, you know, you would pick which school you were transferring to. Then they would tell you if you're taking English 101 at TCC what that would transfer to the other school but that was an online resource. So, I did use their all online resources to help me with the transfer, but I did not use any physical resources such as advisors or anything like that.

Similarly, Maya explained that she did not really use any resources, but she did make sure her classes were transferable before she took them. Maya talked about the ease of using the university's transfer website and how it was very informative during her educational planning stage.

Although the timing of the students' planning phase differed, each student acknowledged that at some point before they attended the four-year university, they took the time to chart out their educational journey. Many of the students were aware of the time it would take them to graduate from the four-year university and what classes they needed to take at the community college. In some cases, the advisors at both the community college and university, helped the students map out their pathways once they decided on a major.

Lauren, Jamie, Tyler, Ariel, Stacy, and Joseph shared stories about how influential their academic advisors were in the educational planning phase and how intentional they were in charting out a transfer plan. Some students like Eric and Maya, utilized the transfer catalogue, they referred to them as "helpful" in charting out their pathway to a four-year University.

Resilience

The second subtheme, resilience, was emerged from six of the ten interviews, more specifically, the recovering attribute of resilience. Walker, Gleaves, and Grey (2006) characterized resilience as both "the ability to recover rapidly from difficult situations" and "the capacity to endure ongoing hardship in every conceivable way" (p. 251). During the interviews, the students shared many experiences in which they exhibited the characteristic of resilience. Resilience, from an educational perspective, is defined by Wang, Haertel, and Walberg (1994) as, "the heightened likelihood of success in school and other life accomplishments despite environmental adversities brought about by early traits, conditions, and experiences" (p. 46).

The students, who attended the community college because of lower levels of academic achievement in high school, a failed experience at a four-year institution prior to attending the community college, or a financial reason, relied heavily on their strong desire to succeed in STEM to drive their efforts of planning and persist despite that experience. There were two students, Eric and Maya, who went directly to a four-year-university after graduation from high school, but transferred to the community college after the first year, with one of the reasons for transfer being their academic performance. They explained their thought process during this "perceived" failure.

Eric stated,

> I had picked that major, it was mainly because I enjoyed repairing things taking them apart you know figuring out exactly how they work. Upon starting the actual coursework, it turned out that there was a lot more physics and math related topics that I didn't feel that I was going to be able to complete to my best of ability. Physics and math are my two strongest subjects. But once we had gotten to like the fluid dynamics statics, that type of courses the workload was just too much for me to handle at the time. My secondary interests besides you know taking things apart was computers. I have always been interested in how they work. Ever since I was little you know whenever my parents would get a new one they would just let me have their old water and I would always you know try to figure out how it worked. My interest has since blossomed to the point where I've built my own gaming computer. I have also built smaller programs, Raspberry Pi, which is pretty much a credit card sized computer that you can take and turn into you know a myriad of different things….So, you know I started off as a mechanical engineer but through the weed out classes you know they did their job. They waited me out and then I transferred over to the computer side.

Maya shared a similar experience,

> I transferred, okay so first when I graduated high school, right after graduating, the following fall actually, I transferred to State University. But I didn't take schooling seriously. I ended up failing a lot of my classes not realizing how hard it was than in high school and after my first semester, I was put on probation after I got like C's and B's and failed 2 classes out of the 5 or 6 I was taking. After

> that, I ended up with another semester off due to inadequate academic standing and then the following semester I got suspended because I still wasn't doing too great in my classes...When I got suspended, I transferred to the community college and I wanted to catch up on the classes that I should have passed initially at State University.

Both Eric and Maya chose their majors based on their early interest in STEM, and once their initial plan did not work, they both re-evaluated their pathway and looked for ways to achieve that goal. Another student, Lynette, talked about how she had a lot going on around the time of high school graduation, so the community college was her only option.

> I had a lot going on at the time, so I just decided to look for community colleges. By the time I really started applying to schools, it was late in the year. The only thing I could do was the community college, and I did feel a little dumb about it because I should have applied to a university. I don't regret it now. Looking back on it, it really helped me over time to know what I need to do to get my bachelor's degree.

Lynette waited too late to apply to any universities, but despite the timing, she did not let this deter her from her goal and found the community college as an option to continue her education.

For Tyler, his motivations were career driven. He described the feeling of knowing his grades were not good enough in high school to pursue his career of choice, but he also found another way to pursue higher education through the community college.

> Well considering the fact that my grades were not good enough to get…Yeah my grades weren't good enough to get into a four-year so if it wasn't for a community

> college, not only would I not be able to do a computer major, I don't think I would have got into a good school...Community college helped me achieve what I wanted to do. It's the hardest thing I have done but I feel like I have a better step because I have the intermediate step. Either I wouldn't have done engineering or I wouldn't have got into a good school such as Carolina University.

For Lauren, it was slightly different. She described the major roadblocks in her journey to a STEM bachelor's degree as the environment of the 4-year school she transferred to after her time at the community college. Lauren described the thought process behind her actions during this time. "It's just not an environment to thrive in, especially the way the classes are set up...finally I got sick of the bio classes and just how all of them were the same so I bumped my minor up to the major."

The students shared that at some point they faced roadblocks during their collegiate experiences, however in many cases, when they met this roadblock they methodically problem solved on how to overcome it. Many of the students' stories included examples of how they were resilient in times of educational and financial crisis, and essentially "recovered" after facing the roadblocks.

Even if I Am the Only One, I Have Support

The last major theme that emerged from the data was, "Even if I Am the Only One, I Have Support." This theme was composed of two major ideas. I used the statement, "Even if I Am the only one" to describe the alienated feelings the students described in their educational journeys as a STEM major. There were three characterizations of the first portion of this theme: (a) feelings of having to prove oneself, (b) stereotypes, and (c) charting a way to diversity. "I have support" highlights the stories from the students on

how they combatted this alienation with specific support systems, which included familial, community, and classroom support.

During the interviews, the students shared how their experiences at the university heavily differed from their experiences at the community college. Many students described the feeling of inclusiveness at the community college, and once they transferred, they faced alienation and competitively charged environments at the University.

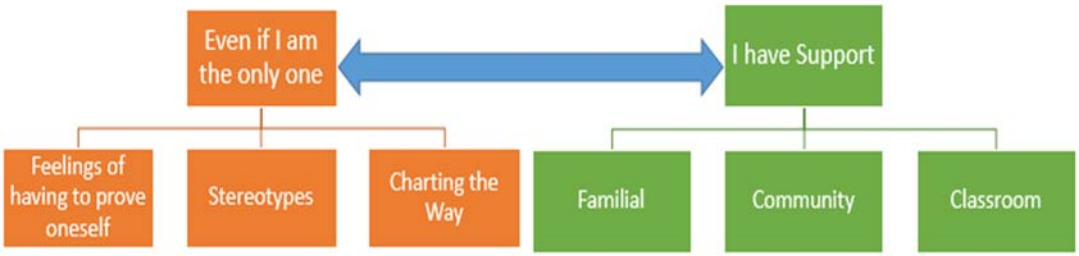

Figure 4.4: Even if I Am the Only One; I have Support

Even if I Am the Only One: Being African American in STEM

"Even if I am the only" was a statement that encompassed the experiences described in the interviews with the students. These experiences was characterized by three components: (a) feelings of having to prove oneself, (b) stereotypes impacting educational experiences, and (c) charting the way to diversity in STEM fields.

Having to Prove Themselves.

The first feeling that characterized the experience of being the only one was the feeling of having to prove themselves. All of the students were familiar with the deficit of African American students in the STEM field and eight of the students acknowledged

themselves as minorities in their classes at the university with the exception of Joseph and Jamie, who both attended a HBCU. Students felt because of the low representation of African American students in their respective STEM fields other students expected them to prove that they deserved to be there.

More specifically, Maya, Joseph, Ariel, Jamie, Lauren, and Lynette felt that people viewed them as a representation of their race in STEM, and this impacted the way they viewed themselves in STEM. Joseph, Lauren, Ariel, and Jamie felt like they had to prove themselves because of their race and in Ariel's interview she explained why her experience had been different than students of other races, "Really the color of my skin or I was trying to prove myself. Every single day I go into the class, I always have to prove myself." Ariel gave an example about how she felt she had to prove herself in her STEM classes, "I always have to have facts and details behind everything I say." Jamie also shared an example of how she felt she had to prove herself in her classes,

> "I feel like this hasn't been explicitly communicated to me but I feel like the expectation for a black student is just low and is low from the time, we start to be in kindergarten school. So, I just want to prove, I personally want to prove myself, I just feel like I have to, it's just something that a lot of black students are told by their parents, you have to try to fight hard."

The students acknowledged that these experiences impacted their personal views of themselves in STEM. They acknowledged the worldly view of who they were supposed to be in STEM as African Americans, as incapable because of the low representation of African American students in STEM. The low representation, among

other things like stereotypes and the presence of microaggressions in the academic environments, internally ignited the pressures of them having to prove themselves.

Stereotypes.

Furthermore, the second characterization of "being the only one" was stereotyping. Combating negative stereotypes was another feeling of alienation in STEM that emerged from the interviews. Some of the students expressed an awareness of stereotypes held against African American students and talked about how it impacted their interactions with other students and faculty.

When Ariel was asked how her experience has been impacted by her race, she answered,

> "Really negatively. Honestly, I am the only African-American women. They stereotype me. Honestly, it really makes me feel like I don't belong here. Usually I don't make comments and stuff which is discussed in class or any projects. I honestly just try to fit in…I just try to stay quiet…They expect me to be like a ghetto type black girl…They already judge me as the way they see me…

Jamie also felt out of place in many of her classes. She stated,

> Just like I said, being the only, being one of very few women and the only black women until very late in my time at the community college…I think because of the nature of the program, there were a lot of people from the rural areas so I had some classmates that were a little bit, how do I say? What is the word? A little bit close minded, I would say….There were not very many black people, and it's kind of lonely.

The students described feelings of loneliness in their STEM classes, and how being a minority in their respective programs impacted educational experience in STEM.

The students were also very aware of their interactions with colleagues and hoped to challenge stereotypical views of African American students in STEM. For example, both Maya and Lynette talked about their views of stereotypes in STEM. Lynette shared,

> I feel like sometimes it's a stereotype for Asians or Asians and Indians to only know Math and Science. But that's not always the case. I even had somebody that was Asian in my education class last semester … And it's a stereotype that only Asians and Indians only know about math or science and nobody else can know about it.

Lauren made a similar statement about an observation on how she was perceived by classmates because of racial stereotypes.

> I would say definitely if you are not white or East Asian or south Asian. You can have a harder time just being approached by other students or even kind of experiencing resistance from your professor or TA, unless the TA is a person of color. So, yeah it seems like there is push back in a way.

She went further to explain how she felt in larger classes, “If I ask a question it would add up to everything these people think about me already, so it’s better to just look like I have it together and ask a question in private.” Jamie talked about a time that her classmates were surprised that she was smart and was good at the work she was doing because of her race. She says, “They didn’t expect me to be that.”

While many of the students described their STEM environments as harsh and unwelcoming, Tyler perceived his experiences a little differently. Tyler described his experience of being one of the few African Americans in his classes as a “commodity”. Which he defined as, “They are rare so you want to…When you see a type of person that

you don't see before, you want to help them out, you know. Decisions that they make aren't so popular so you try to make sense of it."

Although the students described their experiences with stereotyping in their majors, they were hopeful that their completion in the field would inspire other African American students. This leads to the third characteristic of being the only one, which is charting the way to diversity.

Charting the way to diversity in STEM.

The students described a sense of connection with their racial identity, and aspired to serve as a representation of a successful African American person in STEM. During Jamie's interview, she talked about the importance of Black representation in STEM, "I think that my place in STEM is important because not only is it where I want to be but also to possibly be one of few black faces in STEM. Not that there are so few but just to be another representation of what a person in a science field looks like." Later in the interview when asked if she felt like she belonged in her STEM major, she laughed, "I make myself… I kind of just immerse myself and I am there to learn and I would be able to do a good job so it's where I belong whether I feel welcome or not. I feel like I belong." Out of all the students, there was one student, Lauren, who changed her major because of her interactions in the STEM field at the four- year university. She told me the defining story in her decision to change her major,

> It's definitely more of an issue. People not wanting to work with you. The final shock for me was, I had a lab and it was like me and two white guys and a white woman and one of the guys, he didn't talk very much he was very country with his accent, but he didn't talk very much. The other white guy was older and I am

> an older student too so I was 22 or 23 but not super older but he was in his 30's and he would talk over me and the other young lady in our lab group...It was literally just me and him contributing ideas. We were cutting things and examining stuff and if I made a point and say, this is this, I am identifying the body part or whatever, and he would always challenge it and call over the TA to settle a dispute. If I happened to be right and he would just be okay, let's move on but if it was him being right, he would be like, I knew I was right and making a big deal out of it. He would challenge me in ways that he did not challenge anyone else in the group even though he spoke over the other young lady and she was adamant but he wouldn't call the TA over to ask a question. That was actually the last bio class I took after that I switched from the BS to BA. So, I didn't have to take anymore bio classes.

Later in her interview Lauren shared,

> I just think knowing that as a black woman those experiences are going to be more common. Especially going into that field seeing that it is dominated by men, women already have a hard time. And then also being in that kind of space, in America it's dominated by white men so being a person of color for it was going to be 10 times harder for me. It made me think how passionate I am about this? To put up with this. I decided I wasn't. I love it but not that much.

Lauren described her experiences in her biology classes at her four-year school, and her interactions with her classmates because of her race, knowing the statistics of STEM and being aware of the difficulties she would face the further she got in her major she switched. Interestingly enough, Lauren switched to Medical Anthropology, which she

explained that she still was viewed as a STEM field, even though it is not classified as a hard science.

In spite of these experiences, nine of the ten students were still working toward those STEM degrees, and although the students talk about their experiences as a minority, or being the only one, in their respective majors, they overwhelmingly acknowledged that they were still on their journey to a STEM bachelor's degree because of their support systems.

I Have Support: Support Systems

There were three kinds of supports that emerged from the interviews that encouraged students to persist: familial, community, and classroom environments.

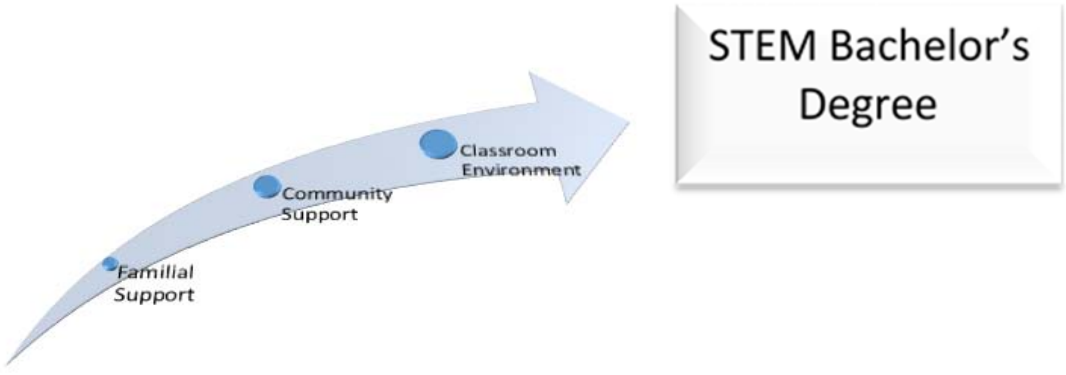

Figure 4.5 Supports to Persistence: Familial, Community, and Classroom

Familial and Community Support

Research examining the persistence of African Americans in STEM heavily connected family and peer support with academic achievement (Buchmann & DiPrete, 2006; Kim & Hargrove, 2013). This finding emerged from this study as well. Familial support constantly appeared in the data.

Six of the students constantly brought up the support and influence of their families on their educational choices. Tyler, William, Lauren, and Joseph talked about having a parent or relative that worked in STEM and over the course of their lives they were exposed to these STEM careers. Joseph specifically talked about the encouragement he received from his family when he faced obstacles in his educational journey and he talked about the continual encouragement from his uncle, "I have one uncle that's an engineer and he talks to me every time I see him and it encouraged me to stick with it." Lynette talked about her mom's influence and support in her decision to major in STEM, who eventually got into education, as her mom is a math teacher.

Eight out of the ten students, Lynette, Joseph, Lauren, Eric, Maya, Ariel, Jamie, William and Tyler described the influence of community support during their educational journeys in STEM. In this study, community support was viewed as friends of families of the students, but were not presented by the student as a family member. Ariel gave a childhood example of this support from her friend's father. She stated,

> I first wanted to do software programming. I guess you can say that my best friend in high school, his dad was a software engineer. So, he was going to do engineering and I was going to do software engineer and we would say that we

> would start a business together. I first thought I was going to be a software engineer, but then I changed my mind and decided to do cyber security.

Another student Jamie found support in her community college program advisors,

> They encouraged me so much. I got an outpour of support from the program. The program was super tiny and I was one of the very few girls and one black girl. I never felt like my professors didn't want me there or questioned why I was there. They would ask me and support me when I said, I didn't know what I wanted to do, maybe this maybe that. They were like go for it. They encouraged me to go pursue the program that I am in now at Technical University. So, they were really encouraging and supportive.

Ultimately, students described the encouragement and support from their parents and peers as influential reasons for why they continued to pursue their STEM degrees.

Community College Classroom Environments as a Support

The students also encountered supportive educational experiences and many of the students talked about how they felt this support strongly in their community college courses. More specifically the students linked a supportive environment to (a) how much the professors cared about them and their learning, (b) the relationships that they built with the professors as a result of smaller classes, and (c) the amount of encouragement they received to continue their educational journeys. Lynette explained, "When I was in community college the classroom is a lot smaller. Now the classes are huge. So, it's kind of hard to sometimes get in contact with your professors."

Stacy had a similar experience, and preferred the smaller class environment at the community college as well, “It was a small environment, so you had to pay attention and it was more engaging in the classes, but at Carolina University the classes are just larger. That’s basically why I enjoyed the community college.”

The students also gave specific examples of how they felt the teachers cared about their learning. For example, Lynette shared a story about the time she was sick and how her community college professor worked with her while she was in the hospital. Ariel, William, and Jamie gave examples of how approachable their community college teachers were. Ariel shares a particular situation where she felt like a teacher went out of their way to help her,

> The professor I had in my math classes at the community college was really lecturey. He always had a connection with each student in the class and also took time outside the class, to check on each student and make sure they were not falling behind. If they had any questions, they could ask them individually. Or if the student wants to ask anything, which you didn’t want to ask in the middle of the class.

Both William and Jamie appreciated that individualized attention from the teacher because of the small classes, and Tyler talked about how welcomed he felt in his classrooms, “The way they taught. Most of them…They would always welcome with open arms. Sit down with you for as long as you need to understand the concept.” Eric summed up the differences in his experiences, at the community college versus the four-year University, with one statement, “I can honestly say that teachers care more at a community college.”

While nine out of ten of the students described their community class environment as small and supportive, with the professors caring about their learning, the students were shocked by the major difference in andragogy at the community college versus the university.

Both Lynette and Stacy preferred the smaller classes and interactions with their teachers, but Lauren expressed her concern with the contrasting experiences at both institutions. She felt that her experience at the community college did not prepare her to be in STEM. She went from small intimate classes with professors, who taught, to being a number in a larger classroom,

> So, they were bigger. I went from being in class with twenty people to four hundred people. The classes were also flipped at ABC University, which is not what I was prepared for. Essentially having a teacher outside the classroom and coming when everything was ready. It also didn't make sense to me. So, I would say that those were the biggest hurdles to overcome. Just being reeducated to a number also just having to teach yourself a massive amount of material, two times a week before you get to class.

For these same reasons, Maya preferred her university courses to those she took at the community college. Maya states,

> I'm certain, I guess. I took the same classes at the University that I took at the community college and to be honest it felt a little too easy or dumbed down than the problems that I have been looking at the University. Like those topics or sections didn't even come up at the community college and that's kind of just

like, I felt like I was getting cheated out of education because it didn't seem like if I had gone on with that knowledge I wouldn't have known enough.

Overall, the students identified a supportive educational environment by smaller intimate classes, relationships with professors, and encouragement in their coursework. The students describe their community college courses and professors as supportive to their goal to transfer and major in STEM at a university.

Summary

The data collected from this study highlighted several educational experiences that shaped the students' connections in STEM, which over time ultimately shaped their STEM identity. Within the theme, "STEM is a Part of Who I Am", I started to see how these students think of themselves within STEM, and understood how they developed their STEM identity. These included positive educational experiences that started in early childhood, increased throughout high school, and were reinforced with familial support, higher student aptitude for STEM, and exposure to STEM careers. Students also expressed the importance of strong familial, community, and classroom support systems in "Even if I Am the Only One, I Have Support" and a strong sense of belonging, within STEM, in "STEM is a Part of Who I Am". This allowed them to overcome barriers of alienation or seclusion that they experienced based on being ethnic minorities. Furthermore, within the second theme "Breaking Through Barriers", students revealed the importance of financial and education planning in their persistence. An inductive approach was used to analyze data from interviews conducted with students who successfully transferred from the community college system. From this approach, the

themes and sub-themes developed provided insight into the STEM identity formation of African American community college transfer students.

CHAPTER 5: DISCUSSION

While there was a plethora of research on community college transfer students that major in STEM, there were not many studies that focused on the intersectionality of race, the experience of being a community college student, and the student's STEM identity. Findings in this study interconnected the experiences of those students, and dove deeper into the concept and development of their STEM identities. These themes uniquely answered key research questions explored in this study. Critical Race Theory provided the platform for this study as the ten African American participants shared their journeys in STEM from their perspectives through counter-storytelling. The participants shared their stories, critiqued dominant ideology in higher education, and shared how dominant ideology impacted their journey in STEM. This was particularly important in relation to STEM in higher education as widely known persistence theories focused on assimilation as key to persistence in higher education. It was also important because more recent research found that harsh academic environments for URMs in STEM and properties of white privilege still existed in STEM fields (Riegle-Crumb, King, & Irizarry, 2019).

This qualitative study was designed to explore how African American community college transfer students who majored in STEM developed a STEM identity, and how these students' educational experiences influenced the development of their STEM identity which increased their ability to persist to degree completion. The data from this study revealed that the formation of a strong STEM identity from childhood both contributed to and resulted from factors associated with persistence, such as support and planning. Both were integral to student success, ultimately providing insight into how

these students situated themselves in their identities in STEM. This discussion will include a comparison of this study's findings to previous research of this kind. Implications of the findings will be examined, and suggestions for future research will be included.

Discussion of Findings

Three themes were developed from the data analysis: a) STEM is a Part of Who I Am, b) Breaking Through Barriers, and c) Even if I Am the Only One, I Have Support.

Research Question One: What educational experiences do African American community college transfer students majoring in STEM perceive as most important to their persistence in STEM?

Within research question one, all three themes contained educational experiences that students self-identified as important for them to persist. These included financial and educational planning, resilience often rooted in a strong STEM identity, and support systems whether familial, communal, or educational. These themes correlated with major factors often found related to former research on student retention (Astin, 1984; Bean & Metzner, 1985; Swail, 2003; Tinto, 1993) which stated that academic preparation, academic engagement, social engagement, financing college, and demographic characteristics were important.

Astin's (1985) Student Involvement Theory examined how the input, outputs, and environments of college influenced educational outcomes such as academic achievement, retention, and graduation. For example, a student's personal, background, and educational characteristics impacted student success in post-secondary education. While these factors were important for student persistence, they were also key for developing STEM identity.

Within STEM culture, persistence and identity were tightly bound and symbiotic. The more the student persisted, the stronger their STEM identity became and the stronger the identification with STEM grew, the greater the likelihood of persisting became. This finding added nuance to Astin's Student Involvement Theory for African American community college transfer students in STEM. The development of a STEM identity served as an 'input' in Astin's model, but also served as an outcome, as it interacted with the students' collegiate environment.

STEM is a Part of Who I Am.

Within this study, the students' connection with STEM, and their identity within STEM, encouraged them to persist. The finding that their STEM identity encouraged them to persist despite barriers complemented research done by Carlone and Johnson (2007), which showed that a student's ability to identify with STEM and STEM careers was associated with STEM persistence. In addition, belongingness as a minority in STEM was a barrier many students in this study had to overcome. A sense of belonging has been shown to be strongly associated with academic achievement, retention, and persistence in college (Strayhorn, 2018), and this study revealed that being the only minority in classes, dealing with microaggressions, and the fear of affirming stereotypical views of people of color were reasons the students felt like they may not belong. The findings revealed that they decided they do belong because of their love of STEM. The findings built on research done by Rainey, Dancy, Mickelson, Stearns and Moller (2018) who found that STEM majors were more likely to attribute their science identity as a reason for their sense of belonging. While the students' STEM identity gave them a sense of belonging in STEM, it still did not offset the feeling of isolation in the classrooms.

This finding also parallels research conducted by Chang (2011) and the National Research Council (2009) which reported that the culture of an environment impacts academic identity and persistence (Chang et al., 2011; National Research Council, 2009). In this study a strong academic identity inspired persistence despite a harsh academic environment.

Astin's Student Involvement Theory (1984) stated that certain attributes brought to postsecondary education influenced educational outcomes. STEM identity, described as an input of a personal or educational characteristic, was one such attribute in STEM education. Because of the role STEM identity served in student persistence of African American students in STEM fields (Carlone & Johnson, 2007; National Academies of Sciences, Engineering, and Medicine, 2016), it was important to understand what impacted the development of STEM identity, how the students connected to STEM and situated themselves in the STEM field.

Breaking Through Barriers with Planning.

Within the second theme, 'Breaking Through Barriers', planning proved to be an important element of persistence that created opportunities for participants' to bypass barriers to success for African American STEM transfer students. The data revealed that the awareness of the educational and financial commitments of obtaining a bachelor's degree before attending school, and the ability to formulate plans to meet those commitments encouraged the students to persist and overcome commonly known barriers to STEM degree completion. This finding aligned with Bean's Model of Student Attrition (1985), which stated that students' attrition was affected by background variables such as high school grades, socio-economic status, family background, and academic potential,

and student's intention such as transfer and degree attainment must be thought about in depth for effective planning. It suggested that increasing students' control of external factors, such as preparation for successful transfer, family commitments, and financial constraints aided student persistence. In this study that was seen through the planning portion of the students' educational journey.

Within this study, I found that there were two types of planning that were crucial to the success of the students, financial and educational. The act of financial planning helped students identify that the community college route was the best for them and contributed to successful transfer to a four-year university. Financial planning also proved to be an integral step for the students to bypass the financial barriers to post-secondary education. This finding suggests that educational leaders need to consider the cost-benefit analysis of attending community college (Jepsen, Troske, & Coomes, 2014). Belfield, Fink and Jenkins (2017) examined the cost-benefit analysis of community college versus four-year and found that even though there was a lower probability of graduating with a bachelor's degree, and a higher chance that one would pay for courses at the community college that would not transfer, the community college was still a cheaper option. My findings also suggested that attendance at the community college, aligned with educational planning and provided the necessary financial support to create opportunities for African American students to obtain STEM bachelor degrees by lowering the overall cost of obtaining a degree.

Furthermore educational planning, the process of charting out the course work to ensure successful transfer to a four-year university, was important for the successful transfer of African American students coming from the community college, and intending

to major in STEM. Much of this information was gained from advisors and guidance counselors at the community college level, and was closely tied to the theme of support systems and the role of a supportive educational environment for persistence. This data aligned with findings from Jackson and Lanaan (2011) who found that transfer student orientations and assistance from advisors increased student persistence for women, another minority group in STEM. This study affirmed that the same was true for African American community college transfer students. My findings suggested these components increased student persistence because of the planning functions of these relationships and interactions. Whether facilitated by an advisor, a family member/ peer, or self-facilitated with resources provided by the University or community college, the students attributed the planning process to their success. The findings supported previous research on the importance of mentoring and advising for URM community college students who intend to transfer and major in STEM (Amelink & Meszaros, 2011; Camacho et al., 2010; Newman, 2011; Packard et al., 2011; Vogt, 2008). In addition, the findings provided deeper insight to one component of advising that added to student persistence, which was educational planning. Educational planning was shown to be a vital part of mentoring and advising relationships that aided the students in a successful education journey in STEM.

Support Systems.

The last theme that emerged from this study, support systems, affirmed previous research on student persistence theories for URMs in STEM. It also provided insight on how support encouraged persistence and the development of a STEM identity. Support systems identified in the forms of communal, familial, and educational support played an integral role in the persistence of African American community college transfer STEM

majors. In contrast to Tinto's Interactionalist Theory, which stated that students must initially separate from the group with which they were formerly associated, students, within this study, held strong ties to their family and community support systems - which encouraged persistence. The data supported the findings of Rendón, Jalomo, and Nora (2000) that challenged Tinto's perspective that student retention was based solely on their ability to integrate and assimilate into the institution. For people of color this adoption of values, can be impossible, as students experienced cultural incongruity in the form of alienation, marginalization, and stereotyping. Many of the students in this study described a hostile environment at the four-year university, but attempted to socially adapt to the environment while holding onto their familial identity, exuding characteristics of dual socialization. Support came in ways of encouragement from the students' families, communities, and educational environments to pursue STEM degrees based on recognized aptitude, especially when met with barriers to persistence.

A unique finding in this study was the support that emerged from the community college classrooms. Tinto's (1997) connection between classrooms serving as communities supported this finding. When examining the dynamics of the classroom, particularly for community college students, Tinto stated, "If academic and social involvement or integration is to occur, it must occur in the classroom" (p. 599). While Tinto examined the role of learning communities in the classroom, the findings from this study showed that the community college classroom environment, alone, was a named support that encouraged students toward persistence. In contrast, within this study the classroom environment at the four-year university served as a barrier.

Many students named the support received from their community college environments as important for their persistence. Overall, support was described by a sense of care from their professors about student learning, relationships built with professors that resulted from their approachability, and better access that resulted from smaller class sizes. The classroom size was welcoming, teachers were more equipped to explain hard concepts, and the overall experience for students was that the professors at the community college cared more.

Students identified the community college environment as supportive, talked about how the environment allowed them to interact with faculty and peers. This supported Pascarella and Terenzini's (1980) Student Involvement Theory, which emphasized the importance of theory from the perspective of student interactions with faculty and peers. Pascarella (1986) focused on the interactions and interrelationships between students and faculty and found that the amount of time spent with faculty, both in and out of the classroom, strongly influenced student intent and persistence. The students described their community college courses and professors as supportive to their goal to transfer and major in STEM at a university.

This finding validated that social integration was much easier for students in a smaller environment, with perceived care from their professors. It also further supported Deil-Amen's (2011) definition of socio-academic integrative experiences as a type of integration at community colleges. If social integration was defined as how well a student socially integrates into the institution, and was dependent on relationships made with faculty and students at the institution, the community college educational environment allowed much more opportunity for this integration. This integration

supported Rendón, Jalomo, and Nora's (2000) assertion that institutions shared the responsibility for the successful cultural and social integration of students into college, and showed the impact of educational environment in aiding in persistence.

Interestingly, in the community college setting, students did not talk about peer interactions as important or not important to persistence, but they did speak of the lack of social interactions, alienation due to negative stereotypes, and having to prove themselves as barriers that they had to overcome in the 4-year university. It was important to study the role of classroom environment in STEM identity development and its influence on persistence.

Development of STEM Identity

The last three research questions focused on components related to the students' STEM identity formation: life experiences, educational experiences, and the impact of race on these experiences. Two of the themes informed the development of the student's STEM identity: STEM being a part of who they are, and the student's continual support in STEM in lieu of not being welcomed into certain social circles and dealing with feelings of societal resistance as a result of being a minority in their STEM classes.

STEM Identity through the Lens of Identity Formation

Responses to research questions two and three - How do African American community college transfer students develop their STEM identity and how have educational experiences contributed to this development? – reflected the process of STEM identity development as experienced by students in this study. Identity formation theories presented by Marcia and Erickson (1993), Hawkins (2005), and Reveles,

Cordova, and Kelly (2004) analyzed in relation to this data gave insight on how these students formed an identity rooted in STEM. Theories presented by Jones and McEwen (2000), Herrera, Hurtado, Garcia, and Gasiewski (2012) and Carlone and Johnson (2007) also provided deeper insight on how the student's STEM identity intersects with the student's other identities as being African American and a community college transfer student.

Hawkins (2005) defined identity formation as an ongoing negotiation between the individual and the social context where learning occurs. Marcia (1993) identified identity statuses through the process of identity formation which included: identity foreclosure, identity diffusion, identity moratorium, and identity achievement. The students in this study all affirmed their identity in STEM, suggesting that identity formation at the highest level had occurred. My findings suggested that at the time of data collection, the students were at the final status of STEM identity achievement as described by Marcia (1993). This status was defined as the point when one has critically analyzed values in comparison to their self-view and made choices to pursue certain options. Figure 5.1 shows the different stages of identity development and how each theme played a role in the development of the students' STEM identity.

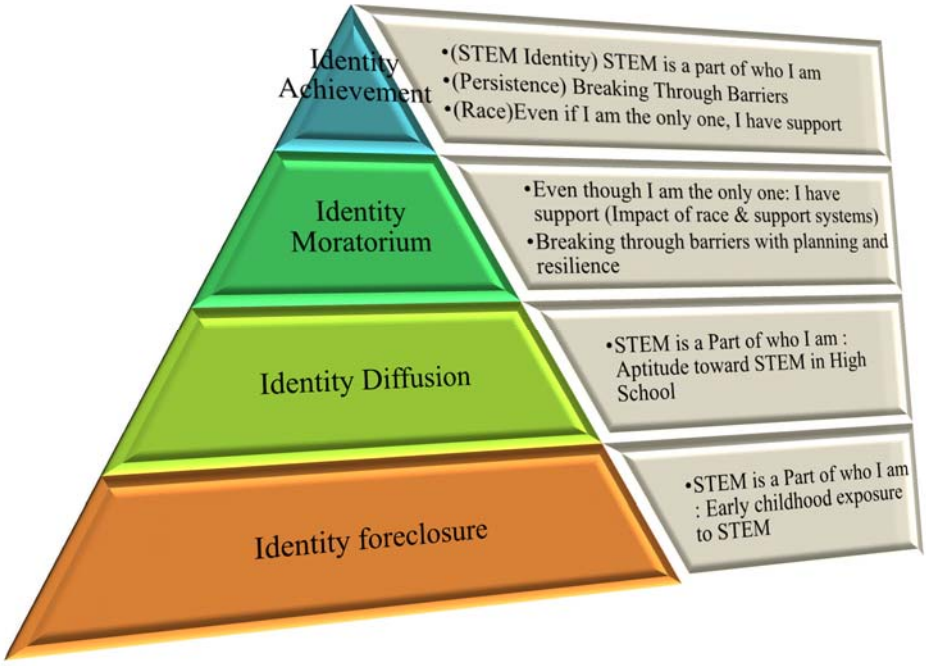

Figure 5.1: STEM Identity Development

Identity formation.

The first status of Marcia's identity formation is identity foreclosure, where students adopt the goals, values, and lifestyle that significant others have prescribed for an individual. While identity foreclosure was not directly mentioned in the interviews, the definition suggested an alignment with my findings as students described having positive experiences in STEM activities as early as elementary school. The exposure to STEM, at an early age by either a relative or a family friend, covertly facilitated this process and moved the students through the identity foreclosure status at a young age. In some cases, the students attributed their interest in STEM as something they might have been born with, but was really the subtle external factors that influenced their identity at this age. For example, a parent working in STEM, or a close family member's decision to take a student to a STEM focused museum could have unknowingly started forming a STEM

identity for the student. Oftentimes, a parent or relative that worked in STEM gave students a visual representation of someone whom they could identify with in a STEM career. STEM exposure encouraged by family members, or close friends and family was therefore an important factor that defined STEM identity. Parents noticing their students' STEM aptitude and cultivating it were other common occurrences within interviews. It could be that the act of affirmation reinforced STEM identity, or the act of cultivation provided more experiences for students' exposure to STEM and received positive affirmations. Many students brought up the support and influence of their families on their educational choices.

Identity diffusion.

The next status, identity diffusion, which was identified as the phase when an individual had not experienced either a crisis nor had committed to a set of values, goals, or beliefs that occurred during the pre-collegiate school years. During this time, the students had the freedom to explore, without commitment or pressure, their interests and what subjects they were most interested in and enjoyed. The identity diffusion status gave insight on how positive schooling experiences influenced STEM identity.

In this study, students evidenced this status as an interest and a higher aptitude for STEM learning during the elementary, middle, and high school and the influence of teachers. Many students described a higher aptitude for STEM learning in high school, indicative of the fact that students performed better in STEM subjects in high school than any other school subjects. They described their experiences in STEM subject matter as more enjoyable, and mentioned an increased interest in STEM during their high school studies.

From early college programs, to hands on exposure through labs, enjoyment and mastery of STEM coursework, high school career fairs, and encouraging high school teachers, these experiences solidified STEM identity, a sense of belongingness, and excitement for STEM. During this time, they described self-competency in STEM fields as validation within an educational setting. Many students spoke about how their high school experiences reinforced their ideas of STEM belongingness, which according to Strayhorn (2018), indicated that students felt like they were a part of a community and were able to connect with others members of that group.

Identity moratorium.

Teachers were especially important throughout the students' period of adolescence, helping students to realize the enjoyment of STEM, especially during the identity moratorium stage of STEM identity development. Teachers were also very much a part of students' positive journeys in STEM within the community college setting. It is interesting that being a low performing student did not deter students from their STEM path once they ascertained their identity in STEM. Instead, they saw the community college as a way to reach their goals. During this analysis, these actions were explained by the identity achievement phase.

Research has shown how the culture of an environment impacted academic identity (Chang et al., 2011; National Research Council, 2009). In this study, STEM identity, reaffirmed by faculty at the community college, was similar to students' high school experiences. The students describe their community college courses and professors as supportive to their goal to transfer and major in STEM at a university, which reinforced STEM identity.

Previous research described the classroom context as a place where individual and collective identities were constructed through specific classroom discourse between teachers and students (Reveles, Cordova, & Kelly, 2004). It asserted that students' perceptions of self were altered over time to meet the demands and expectations of their teachers. Carlone and Johnson (2007) highlighted the importance of a student recognizing themselves as a scientist and being recognized by others as a legitimate science person. Teachers were ideally situated to play this role and did so in the experiences of these students. This reinforced the concept of science identity depending on social interactions.

Identity moratorium occurred at different stages for different students. During this phase, the gradual exploration of personal and occupational choices occurred, and for this population of students, this time was described as a time of instability regarding values, goals, and beliefs, reflecting the experience of a crisis, without the resulting commitment. For some students, this stage occurred during high school, for others it occurred at the community college, and there were a few that experienced this at the four-year school. Crisis in this study was described as academic failure in a STEM class or post-secondary institution, and although the students had made small commitments at this stage, the data revealed that they were reflective and chose to persist which deepened that connection to STEM. This stage was where we see the students engaged in the resilience that Wang, Haertel, and Walberg (1994) defined as persistence despite adversity.

Identity achievement.

My findings proposed that the STEM development in the first three stages was so strong in these students that they overcame crisis and migrated to the identity achievement phase. During this phase, the students critically analyzed their values in

comparison to their self-view and made choices to pursue STEM despite experiences of crisis. One aspect of their self-view was grounded in how they understood their approach to problem solving. A novel finding in this study, that is not often associated with traditional STEM definitions, is that students described their connection with STEM as a way of thinking and how they solve problems. These factors facilitated performing well in STEM and maintaining their interest as well. Reveles et al. (2004) previously suggested that academic identity formation was a function of how students perceived themselves as being capable of completing academic tasks, performance. The type of problem solving that the students described as natural to them was a methodological process that mirrored the scientific method of observation, measurement, and experiment. Hypothesis-driven thinking (scientific method) was described as a way of looking at and reevaluating results. Knowledge of these processes would have been learned in classes where they had to find unknown variables. This methodology was applied across every aspect of life, even personal matters for some of the study participants and resulted in a sense of satisfaction. Displaying commitment affirmed their status of STEM identity achievement. The findings from this study closely aligned with Carlone and Johnson's (2007) definition of STEM identity that characterized a strong STEM identity as an individual's competence through skill demonstration and scientific knowledge or performance, but highlighted the fact that it was necessary for the individual to be recognized as having this knowledge in STEM.

The themes, STEM is a Part of Who I Am, and Breaking Through Barriers provided a deeper understanding of how African American students who successfully transfer developed this connection with STEM. Ultimately, research defined STEM

identity as a student's ability to (a) perform well in STEM subject areas, (b) identify with STEM careers, and (c) socially connect with people in the STEM field. Students in this study seemed to do each. In alignment with Erikson's (1963) Identity Formation Theories, stages of growth over the course of the elementary through 4-year college experience impacted students' STEM identities, reflecting critical developmental periods over which students were able to integrate various experiences within STEM. This in conjunction with family and community support provided a foundation for developing a STEM identity.

Through the Lens of Critical Race Theory

Research Question Four: How does race influence the development of STEM identity in African American community college transfer students?

In higher education, CRT is used to unveil systematic racism and hegemony in education. The anti-deficit achievement framework highlighted the students as experts on how to navigate STEM fields as African American STEM persisters, while also unveiling how dominant racial ideologies impacted their journey in STEM and the development of their STEM identity. The use of counter-storytelling served as a platform for the students as they were able to share their stories of successes and failures within their STEM journeys as African American community college transfer students.

STEM is a Part of Who I Am.

The theme STEM is a Part of Who I Am, showed the strength of the student's STEM identity developed over time through their life and educational experiences. The findings showed that for these students their race did not seem to directly influence the way they viewed themselves in STEM. It did however, heavily influence their

educational experiences, especially at the four-year universities, and this in turn impacted the way they viewed themselves in society in relation to STEM.

This finding provided a different view from studies that asserted that academic success was achieved at the expense of a positive sense of racial-ethnic identity (Conchas, 2006; Kunjufu, 1995; Noguera & Wing, 2006). The students in this study recognized that in many cases they were minorities in the field, but were hoping to increase representation by serving as role models and hoping that their success in the field would encourage more African American students to join. The students persisted because of their strong connection to STEM and a described support system. This finding creates an opportunity for future research on how African American student support systems relate to positive cultural identities.

While there was an interest in STEM from African American students, somewhere in their pathway to that STEM career, there were experiences that causes them to depart. In this study, these barriers were most apparent in their post-secondary education and highly associated with their experiences as being African American in white spaces. The findings from this study supported the notion that STEM college courses lacked inclusive andragogy and fostered unwelcoming harsh environments in STEM. These conditions still served as major barriers to STEM degree completion for African American students. Although, this barrier did not impact the way the students viewed their identity in STEM, it impacted persistence.

Even if I Am the Only One, I Have Support.

In STEM fields, the CRT tenet that racism is permanent was evident in how many of the students described their STEM environments at the four-year universities. These experiences were not described as overt racism, but as microaggressions experienced during peer interactions. The theme "Even if I Am the Only One" embodied the influence of race on the student's educational experiences. Over the course of their educational journey, with more pronounced experiences at the four-year universities, the results from this study found that students felt they had to prove themselves, and dealt with stereotyping, but essentially combatted these negative feelings with one of triumph. The idea that the students were charting the way to diversifying the STEM fields by pursuing their respective STEM degrees, along with their support systems cheering them on, decreased the impact of these negative experiences on the students' persistence. This finding also affirmed Phinney and Ong's (2007) theory about the development of an ethnic identity. The attribute charting the way to diversity showed how the students shared a sense of identity with others who belonged in their same ethnic group and desired to succeed in impacting the view of STEM within the African American community. This finding also supported existing literature that found that URMs that persisted also must counteract stereotypes, such as being unintelligent and lazy (Fries-Britt & Griffin, 2007), that were embedded in organizational norms and practices with their personal, cultural, and co-curricular resources.

Research has shown that URMs faced stigmatizing experiences in the forms of discrimination, microaggressions, and limiting stereotypes, (Chang et al., 2011; Fries-

Britt & Griffin, 2007; Yosso, Smith, Ceja, & Solórzano, 2009). Some of the students were impacted by stereotype threat (STT), the fear of being a risk of confirming, as a self-characteristic, a negative stereotype about one's social group (Steele & Aronson, 1995).

Students felt that because of the low representation of African American students in their respective STEM fields, other students expected them to prove that they deserved to be there and combat negative stereotypes. This study affirmed that African American students that transferred from the community college dealt with the same challenges. My finding however brought insight that post-secondary educational experiences widely vary from the community college to the four-year university in terms of racial inclusivity as the student's race became more evident once they transferred.

The students described harsh environments in post-secondary education, while serving as a barrier to persistence, these barriers did not overtly impact the way the students viewed themselves in STEM. This finding presented another area for future research on how educational leaders need to quantify "harsh" environments, measure them on a micro level by classrooms, and develop strategies to decrease them in STEM post-secondary courses. Ultimately there is a component of, being the only one, a minority in STEM in harsh academic environments that served as a barrier to student persistence. The tenet of color blind pedagogy was apparent in the student's journey to a STEM bachelor degree. Students were expected to conform to their environments if they wanted to succeed. The student participants in this study expressed their feelings of isolation and alienation associated with their race, and equity within higher education STEM environments proved to be a major issue.

The findings from this study provided a more in-depth understanding of how this connection developed for each student, while presenting new discoveries on STEM identity development for this select population of students. STEM identity was heavily influenced by a student's perception of themselves and how they fit within their environment due to their experiences and beliefs about STEM. As the definition of STEM identity evolves and becomes more concrete, the findings from this study will better inform how this identity is formed in conjunction with the student's intersecting identities.

Implications for Policy, Practice and Theory

Although African American students pursue STEM degrees at similar rates as their White peers, STEM was the only field where African American students were significantly more likely to switch and earn a degree in another field even after controlling for academic preparation and social background factors (Riegle-Crumb et al., 2019). As the United States looks for ways to increase and diversify its STEM workforce, and utilize the community college as an avenue to accomplish this goal, there continues to be a need of understanding factors that influence the development of a strong STEM identity. Ultimately, this would lead to increased persistence for African American students who want to use the community college as a pathway to a STEM career. Therefore, this study was significant because it contributed to the literature on STEM identity development of African American students who have transferred from the community college. This study was relevant because of the limited number of studies focused on STEM identity development for African American students who utilized the community college in their pursuit of a STEM bachelor's degree. In addition, it added to

STEM persistence literature by including stories of African American community college transfer students majoring in STEM and the educational experiences they perceived as most important to the development of their STEM identity. Lastly, this study examined how race influenced the development of the student's STEM identity.

Some implications from this study for STEM persistence and STEM identity development of African American community college transfer students included: (a) the importance of early-childhood programs, (b) the impact of STEM connections in formalized education, (c) the importance of financial and educational planning in STEM persistence for African American community college transfer STEM majors, (d) the importance of support systems, and (e) the need to hold higher education institutions responsible for harsh STEM cultures, climates, and environments that serve as barriers to persistence for students of color.

In order to attract students from URM groups, policymakers should increase the number of affordable early childhood programs rooted in STEM pedagogy in communities with higher minority populations. Emphasis on the importance of early childhood education in STEM should be provided to parents, specifically in areas with larger populations of minority groups. Parents would then be able to introduce their children to STEM concepts even if they had not previously been exposed to STEM pedagogy. A program like this could create more social capital for those communities that have a low number of STEM professionals or influencers which in turn could positively impact the community..

This study also revealed the importance of teaching scientific problem solving skills in STEM identity development. Elementary, middle and high school teachers

should teach students to apply the scientific method to solving problems outside of the classroom as this increases students' connectedness to STEM which ultimately encourages them to persist and develop STEM identities. Elementary, middle and high school teachers are instrumental in the development of STEM identity and teaching students to apply the scientific method to solving problems outside of the classroom increases student's connectedness to STEM.

For educational leaders, parents and student advisors should focus on educational and financial planning processes as the findings of this study showed both were instrumental in the successful transfer of African American STEM students from the community college to four-year universities. While this process was currently facilitated by advisors and mentors, it can also be self-regulated. The process of educational and financial planning should be facilitated at the elementary, middle school, high school, and college levels.

Lastly, the STEM environment at four-year universities was described as harsh by African American students. If policymakers are serious about increasing diversity in the STEM workforce, they need to examine the classroom environments and provide training to professors on how to create an equitable environment in these classrooms.

Implications for Future Research

The findings from this study introduce new areas for research around STEM identity development and student persistence for African American students. More research is needed on:

1.) Differences between the classroom culture of STEM programs at different types of institutions. While many of the students described the differing experiences at

the community college and four-year universities, a deeper look at the culture within the classrooms is needed.

2.) To quantify "harsh" academic environments. Research providing educational leaders a standard to hold their classroom environments to could raise awareness of the presence of a harsh environment in STEM departments.

3.) A comparison of the persistence of African American community college students who intended to transfer and major in STEM, but did not successfully transfer to those who did would be helpful in examining areas for growth at the community college. The findings from this study revealed that the positive experiences with STEM at the community college aided in the development of STEM identity for African American students. A study on those students who faced additional barriers to persistence at the community college would inform community college research.

4.) How and if an inner sense of belongingness with STEM pedagogy mitigate feelings of isolation and any other obstacle that threaten students' STEM identity.

5.) How African American student support systems in STEM relate to positive cultural identities in relation to STEM.

6.) How the experiences differ between African American community college transfer students who major in STEM at HBCUs, PWIs, private, or public universities.

7.) How, and if post-secondary institutions, and STEM department chairs are seeking to create an equitable environment for all its students pursuing STEM bachelor degrees.

Limitations

The scope of this study addressed the experiences of African American community college transfer students majoring in STEM. However, there were limitations that were not addressed in this study that were discovered during the study process. The criteria called for African American community college transfer students who were currently enrolled in a four-year university and majoring in STEM. This criteria did not take into account the type of four-year university the students were currently enrolled, and therefore the students' experiences varied by institution and program type.

Summary and Conclusion

Within this chapter, a discussion was presented based on the data analysis of ten qualitative interviews and a review of the literature surrounding identity formation and persistence. This study explored perceived factors that affect persistence for African American community college transfer students, and compared and contrasted these findings to foundational theories on persistence across a broad audience, and to those that take into account challenges faced by specific minority communities.

The findings from this study strongly aligned with persistence theories that account for unique personal, familial, and educational experiences minorities in STEM faced and how they shaped their STEM identity. I have discussed STEM identity formation, highlighting the impact of race and educational experiences in comparison to the major literature on identity formation, and specifically STEM identity formation. These findings highlighted the importance of human interactions in the formation of STEM identity, and positive educational experiences stemming from early childhood. STEM identity was solidified by an internal sense of belonging in STEM that students often pondered. Students could not envision themselves in any other field. STEM identity within this study, seemed to be one of the strongest motivators to encourage resilience,

which resulted in persistence. Furthermore, the community college was a method for them to achieve their means and circumvent academic and financial hurdles. The interviews provided invaluable data to understand lived experiences of minority students that transferred from the community college and successfully persisted in STEM. The implications for this research are important as it provided data to support cultivation of educational environments that are inclusive and supportive of minority students in STEM.

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APPENDIX A
Interview Protocol

Four-Year Transfers Follow-Up Interview Protocol

April 10, 2018

Note to interviewer: read their first interview, keep in mind and follow up on any conflicting statements.

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 respondent's number ("you are respondent #2")
General Questions about Majors and Post-Secondary History	1. Currently you are attending {your school}, correct? And you transferred from {community college}? 2. What is your major? (if more than one focus questions on STEM 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. a. Ask lots of questions as they share on details. 4. {If not previously answered and student is NOT a STEM major} When we interviewed you two years ago, you were considering a major in a STEM field. Why did you decide against pursuing a STEM major? a. Ask lots of details 5. What is your college enrollment history? a. Probe for whether they began at community college, whether they were ever dual enrolled, 6. When did you first know you wanted to major in {major}? a. What was the most influential factors b. what has encouraged you toward that major

	c. what has discouraged you 7. If you could do it all over again would you pick a different major? 8. Did you consider other majors? Why did you not pursue them? a. For life and environmental science majors: Did you ever consider a physical science major like engineering or physics? Why did you not consider and/or pursue? 9. Did attending community college have an impact on your choice of major? a. Do you feel that you would be a {your major} if you had not attended community college? 10. How does your family feel about your decision to major in {current major}? 11. Thinking back to when you chose your major, were you also thinking about a career? *If yes:* • *How does this major fit with your career plans?* 12. What kind of career/life plans have you made since you decided to major in {your major}? How does this major fit with those plans?
Interest in Science	1. Since you started taking college classes, 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? *a. Probe for class experiences, research opportunities, internships* *b. Ask for an example of an event that increased or decreased interest.*
Pedagogical Experiences and Interactions with Teachers	We are interested in your experiences in the classroom. First I'm going to ask about your experience in the CC and then about your experience at {your 4 year school} 1. Did you take any science classes at your community college? What about Math? {If none of these classes, then skip to next section. a. Did you enjoy classes in science/math you took in community college? Why b. Do you feel science/math classes were taught well? Why or why not? c. *If not mentioned for (5) and (6) above follow with* d. *Do you think your science/math instructors at community college enjoyed and were interested in teaching? Explain.*

	e. *Do you think your science/math instructors cared about you and your learning? Explain.* 2. Did any of your science/math teachers stand out as being very influential in your choice of major, positively or negatively, why? Now think about your experiences at {your 4 year school) 3. Have you enjoyed classes in {their major} you have taken since you entered the four-year college? Why or why not? 4. Do you feel your {major} classes are taught well overall? Why or why not? a. What criteria do you use to judge if a course is taught well? *5. If not mentioned for (1) and (2) above follow with* *a. Do you think your {major} instructors at college enjoy and are interested in teaching? Explain.* *b. Do you think your {major} instructors care about you and your learning? Explain.* *6. In the main section of the course (not the lab section), to what extent do your {major} teachers lecture vs. use more active approaches such as encouraging student discussion, cooperative learning and hands on activities?* *i. Would you prefer a different emphasis?* *ii. On average how different are your (4 year) courses compared to your CC science/math courses regarding the use of active approaches?* 7. Did any of your (major) teachers stand out as being very influential in your choice of major, positively or negatively, why? 8. Did you consider the degree of work-life balance in your future career when deciding what major to choose? a. {probe} How important is a balance between work and family life to you? b. What indication do you have as to the work-life balance of the jobs that people with your major do? c. Were there other majors you considered but did not pursue due to the perception that it may not support a work-life balance?
Transfer Process	1. How did you come to attend {your current school}? • *Probe for proximity to family and to jobs* • *Probe for tuition considerations* • *Probe for contacts between university faculty/recruitment efforts and community college* 2. How is the experience being at (their 4 year school) different from your experience at the community college?

	• *Probe for social adjustment, academic adjustment, and ease of transfer of credits from CC to the four-year* 3. When you transferred, what was your class standing (first-year, sophomore, etc)? Was that what you were expecting? • *Probe for how many semesters total they will be at the four-year school* 4. What resources at the community college did you use to help prepare you to transfer to {current school}? These might include tutoring, learning centers, career counseling, advice about financial aid, or people like advisors or instructors. • Were you satisfied with the community college resources that helped you transfer? • Probe for usefulness of different resources if they don't mention. 5. Since transferring into {your current school} have you taken classes at a community college? • If so, what courses? Why did you take them at the community college?
Identity and Confidence Issues	1. Do you think of yourself as a STEM person? Why or why not? • Probe for experiences that help them know they were a STEM person or if they answer no, what experience would make you feel like a STEM person? 2. Does your STEM connection ever conflict with any other views you have of yourself? Why 3. How confident do you feel in your {major} classes. Explain. • How do you think your confidence compares to the confidence of other students in your major? • What situations tend to increase your confidence? (probe for a specific example if they don't give one) • What situations tend to decrease your confidence? (probe for a specific example if they don't give one) • How has your confidence changed over the last couple of years? 4. 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? Explain. 5. 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? Explain. 6. Do you think that people view you differently because you transferred from a community college? If so, who and how? 7. Describe a typical student majoring in {major}. 8. 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? 9. How often do you socialize with people who are {your major} majors? Do you enjoy socializing with typical {major} majors? 10. How often do you study with other students in {your major}?

	11. Do you think you are more or less connected to your classmates than a typical student in {your major}?
Gender and Race Questions	1. How do you identify in terms of gender? Race or ethnicity? 2. Roughly, what percent of students in your major are like you in terms of gender? 3. In terms of race? ***(note to interviewer: in the following questions if there is any ambiguity about whether they are talking about CC or 4 year probe for clarity)*** 4. Do you think the experience of pursuing a {your major} major is different for people of different gender groups? If so how? a. Has your experience been impacted by your gender? 5. Do you think the experience of pursuing a {your major} major is different for people of different races? If so how? a. Has your experience been impacted by your race? b. Do you think your race has impacted the way: i. You view yourself in STEM? If yes, how? ii. You interact with some of your peers? faculty? If yes, how? iii. The way your faculty and peers view you? c. Do you feel like you ever have to prove yourself because of your race? If yes, how? 6. Do you think anyone in {your major} has encountered sexism? If yes, ask for examples. Be sure that it's clear what they mean by sexism. 7. Do you think anyone in {your major} has encountered racism? If yes, ask for examples. Be sure that it's clear what they mean by racism. 8. How often are race and/or gender issues discussed in your {major} courses? Ask them to elaborate. 9. Are there any aspects of your identity that lead you to experience your major differently from other students? 10. Do you ever feel like you can't express yourself in class because of what others might think of you if you did? 11. Most men see less sexism in the world than women do. Most people of color see more racism in the world than White people do. Can you speculate on what causes these differences? 12. (if not addressed already) You haven't mentioned CC experiences yet, was the CC environment different from your 4-your college experience? If so, probe for more about how.
Final Question (s)	1. If you had the chance to do over, would you still have attended the community college? Why or why not? a. Would you recommend this path for others?

	2. What are the important experiences that have kept you in your STEM major? 3. 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? 4. (Thank them for participating and remind them to send in their paperwork for payment.)

APPENDIX B

Recruitment Email

Recruitment Email Title: Interview for $25 visa gift card

Email Body:

Good afternoon,

A team of researchers in UNCC's Department of Sociology is recruiting student participants in a study about student's academic experiences. We're looking for students **who might want to earn a $25 Visa gift card** in exchange for volunteering to be interviewed about their academic history. Interviews will be conducted via phone.

You may participate in this project if you meet the following criteria:

- Self-identify as Black/African American and;
- Have transferred from the community college to a four-year school and;
- Are currently majoring or have majored in a STEM field once you transferred to the four-year school

Please contact the study's Principal Investigator, Elizabeth Stearns, or email the graduate student, Yolanda Kennedy to let them know whether you might be interested in participating in an interview. Their contact information is listed below:

Yolanda Kennedy

ylkenned@uncc.edu

404-594-1503

Elizabeth Stearns

Elizabeth.stearns@uncc.edu
704-687-7834

This is a study conducted at UNC-Charlotte and cleared by their Institutional Review Board.

Thank you!

Yolanda Kennedy

Doctoral Candidate UNC Charlotte

APPENDIX C: Consent Form

The University of North Carolina at Charlotte
9201 University City Boulevard
Charlotte, NC 28223-0001

Department of Sociology
(704) 687-7806
Fax: (704) 687-1397

Project Title: **Community College Roots of STEM: Interactive influences of individual, secondary school, and college factors predicting the success of underrepresented groups**

Primary Researchers: Elizabeth Stearns, Roslyn Mickelson, Stephanie Moller, Melissa Dancy, and DeeDee Allen

CONSENT TO PARTICIPATE IN A RESEARCH STUDY
"Finding the Roots"

You are being asked to participate in a research study, "Finding the Roots." The purpose of this research study is to better understand community college students' academic experiences, including how they select their majors and create their STEM identity. Please read this document, which has been e-mailed to all participants, carefully. At the beginning of the interview, you will be asked to give your verbal consent if you agree to participate in the study.

There are several researchers conducting this research project. They include: Dr. Elizabeth Stearns, a UNC Charlotte Professor in the Department of Sociology; Dr. Roslyn Mickelson, a UNC Charlotte Professor in the Department of Sociology; Dr. Melissa Dancy, a University of Colorado-Boulder Research Professor; Dr. Stephanie Moller, a UNC Charlotte Professor in the Department of Sociology; Dr. DeeDee Allen, a Wake Tech Professor in the Sciences; and Dr. Martha Bottia, a UNC Charlotte Assistant Research Professor in the Department of Sociology. Cayce Jamil, Yolanda Kennedy, and Edward Averette, students at UNC Charlotte, will be assisting. Yolanda Kennedy will be using this data in a dissertation study.

You have been contacted about this study because you said that you would be willing to participate in a follow-up interview. There will be a total of approximately 200 participants in this study.

You will be interviewed by research staff for approximately sixty (60) minutes. The interview will consist of questions about your academic history and how you came to choose your current academic major. The interview will be audio recorded. The audio recordings will be transcribed by paid transcribers.

It is possible that talking about some of your academic history could make you feel uncomfortable. You are welcome to skip any questions that make you feel uncomfortable, and you may also stop the interview at any time.

Some people find talking about their academic histories and college majors to be helpful. A possible benefit of this study is that the results may help other people better understand how students make decisions about which majors to choose.

You will be paid a $25 Visa gift card for completing this interview.

The research team will make every effort to protect your privacy. All your responses to the interview questions will be kept confidential. The digital audio recording files will be kept on a password protected computer in a password protected folder. The recordings will be coded by a number rather than your name. After the audio recording is transcribed, it will be destroyed. The transcriptions will contain no identifying information. During the study, all transcription materials will be kept in a locked filing cabinet in a locked office. When the results of this study are published, participants will be referred to by pseudonyms, not names.

The decision to participate in this study is completely up to you. You will not be treated any differently if you decide not to be in this study. If you decide to be in the study, you have the right to withdraw from the study at any time.

UNC Charlotte wants to make sure that all research participants are treated in a fair and respectful manner. Contact the university's Office of Research Compliance at (704)-687-1871 if you have questions about your rights as a study participant. If you have any questions about the purpose, procedures, and outcome of this project, contact Dr. Elizabeth Stearns (704-687-7834, Elizabeth.stearns@uncc.edu).

This form was approved for use on *November 20, 2017* for a period of one (1) year.

I have read the information in this consent form. I have had the chance to ask questions about this study, and those questions have been answered to my satisfaction. I am at least 18 years of age, and I agree to participate in this research project. I understand that my verbal acknowledgement indicates my informed consent.

Contact Information

Primary Investigator
Elizabeth Stearns
Elizabeth.stearns@uncc.edu
(704) 687-7834

Office of Research Compliance UNC Charlotte
http://research.uncc.edu/compliance-ethics
(704) 687-1871

APPENDIX D: Prize Winner Documentation Form

FINANCIAL SERVICES

PRIZE WINNER DOCUMENTATION FORM

Event Name Finding the Roots Interview

Event Date

Full Name of Prize Recipient

(please print)

Permanent Home Address

Campus Address, if different from above

Home Telephone Number

Campus Telephone Number

Prize Won

Prize Value

Serial Number of Gift Card or Gift Certificate, or Description of Prize Awarded
$25 Visa gift card

I certify that I am the winner of and have received the prize identified above. I understand that this prize may be subject to federal tax reporting and/or withholding.

Signature

Date

Instructions for completion of Prize Winner Documentation Form:

1. Have the prize winner complete the form.
2. Attach a copy of the gift card/certificate showing the serial number of control number of the card/certificate.
3. If the prize recipient is a nonresident alien, attach a completed Foreign National Information Form. If additional information is needed from the recipient, they will be contacted.
4. Submit completed documentation to Travel & Complex Payments, Reese Building, 3rd Floor.