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Telling Our Stories: Exploring the Path Toward Successful Mathematics Degree Attainment at an Under-Resourced Predominantly Black Institution

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The primary research question guiding this study was: What are the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution? Concurrently, this interpretive case study examined and documented the experiences of four graduates from one of these programs by means of in-depth phenomenological interviews. The three 60- to 90-minute interviews focused on life history, the college experience, and a reflection on the meaning of that experience.

The participants' counternarratives were abstracted into three overarching themes which contributed to persistence and success: (1) people who cared, (2) sense of belonging, and (3) personal agency. The findings and themes from this study suggest that the challenges and opportunities are interconnected, and a successful mathematics degree program relies on the integrity of its community to creatively use its limited resources, and to recruit students and faculty from within to help teach one another and intentionally build a cycle of excellence.

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Lauren E. McKittrick

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If you don't find the time to document your own history, it is likely to be forgotten, or, worse still, misrepresented. (Rex Nettleford)

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Chapter 1: Introduction

Before this study materialized, I was simply an urban educator. An elementary mathematics teacher. I had no idea that I would someday find myself across the country inside a college mathematics department, speaking with people years downstream educationally and yet so closely aligned with the children I face every day in terms of aspirations and limitless potential. I can almost hear their echoes in my voice as I continuously tell my grade school students – children who statistically and systematically are expected to fail – that they too will succeed at whatever path they choose.

Regardless of what I say to my students, the facts remain true. Grave inequities exist in the United States among races, genders and ethnicities due to historic legislative mechanisms, sociopolitical contexts, and educational practices and processes (Bonilla-Silva, 2001, 2014; Howard, 2010; Massey, 2007). These longstanding systemic, institutional disparities have had a profound effect on educational opportunities and outcomes for under-represented populations including minorities and people living in poverty (Diamond, 2013; Howard, 2010; Oakes, 1990; Tyack, 1995). Black students in particular have persistently shown lower high school graduation rates, college enrollment, and college graduation rates compared with the general population, and in comparison to Whites (Jackson, 2015; National Science Board, 2016). These gaps in educational outcomes extend through the higher education system and into career paths; historically Whites and Asian Americans show higher success rates in STEM degree programs and

fields than Blacks, Hispanics, and Native Americans combined (National Science Board, 2016).

Research indicates that African Americans are significantly underrepresented as a proportion of those both enrolling and succeeding in STEM programs at colleges and universities, and as a percentage of the national STEM workforce (U.S. Commission on Civil Rights, 2010). Despite remediation efforts, one-third of all Black men who enter higher education leave before completing their degree, and just two out of five African American and/or Hispanic students remain in their majors and receive bachelor's degrees in a STEM discipline nationwide (Alkhasawneh & Hargraves, 2014; Strayhorn, 2015). Still more pronounced is the disparity in mathematics, a field in which Blacks and African Americans are considered to be "missing persons" because the percentages are so low in proportion to the general population (Strayhorn, 2015).

To quantify these missing persons: Of the 880 American citizens who received doctoral degrees in mathematics in 2014-2015, 115 were Black, Hispanic, Asian, or Native American. A mere twenty, or just above 2%, of those people were Black. Comparatively, nearly 14% of the general American population is African American according to 2010 census data (Rastogi, Johnson, Hoeffel, & Drewery, Jr., 2011; Vélez, Barr, & Rose, 2016).

Many scholars have studied and theorized the trends associated with these achievement gaps, effectively normalizing White achievement versus minority underachievement and contributing toward a myth of Black intellectual inferiority (Gutiérrez, 2008; Hilliard III, 2003; Howard, 2010, 2013; C. D. Lee, 2012; Massey, 2007; Steele, 2003). This dissertation intends in part to disrupt that myth. This study

documented the stories of 4 graduates from an undergraduate mathematics degree program at an under-resourced Predominantly Black Institution, and used those narratives to explore the challenges and opportunities associated with creating and sustaining a successful mathematics degree program committed to access and excellence.

This study took place at a four-year public college in the eastern United States. Clementa Pinckney College (CPC), a Predominantly Black Institution (PBI), launched an undergraduate degree program in mathematics in the fall of 2000, and the program has since graduated almost 40 students of color with undergraduate degrees in mathematics. More than 30 of those graduates are Black.[1] Who are these graduates? What did their paths to success look like? Their stories are important because they can inspire future generations of Black students, aspiring collegians, and potential mathematicians (Perry, 2003; Walker, 2014).

The number of successful Black mathematics graduates at CPC is noteworthy given the difficult task of achievement for Black students who pursue mathematics degrees (Perry, 2003; Walker, 2014). Many minority students, including a substantial proportion of those who enroll at CPC, attend elementary and secondary schools in under-resourced districts with limited access to quality teachers and rigorous, culturally-relevant instruction that would adequately prepare them for college attainment in mathematics and science (Atuahene & Russell, 2016; Howard, 2010; Nieto, 2010; Picower, 2009). This lack of opportunity during kindergarten through high-school (K-12) schooling diminishes their chances for success at the post-secondary level, leading toward higher attrition and

[1] All forthcoming data and information specific to study site demographics, success rates, and program offerings were retrieved from the study site's college website and Office of Institutional Research, unless otherwise noted.

dropout rates for Blacks and other minority students (Archbald & Farley-Ripple, 2012; Atuahene & Russell, 2016; Howard, 2010; National Science Board, 2016; Oakes, 1990). A significant responsibility falls on colleges and universities to have the systems and structures in place that will ensure that Blacks who pursue mathematics degrees ultimately succeed (Preston, 2017).

Statistically, PBIs and other Minority Serving Institutions enroll the students who are least academically prepared for college and most vulnerable to the challenges that can affect their well-being, stress- and satisfaction-levels, and likelihood of persisting and attaining a degree (New America, 2015; Radford, Cominole, & Skomsvold, 2015; U.S. Commission on Civil Rights, 2010). These institutions must therefore dedicate their limited resources not only to high-quality instruction, but also toward college access and supportive college experiences (Jones, 2015).

Problem Statement

There is a gross underrepresentation of Black people in the field of mathematics. Blacks represent a mere 3.4% of the STEM workforce and less than 2% of mathematicians nationwide (Atuahene & Russell, 2016; Newell, Gipson, Rich, & Stubblefield, 1980; Strayhorn, 2015; Walker, 2014). Despite policy initiatives which target both K-12 and postsecondary success for minority students, these trends have remained flat since the 1970s due in part to disparities in educational opportunities and outcomes (Heilig, Reddick, Hamilton, & Dietz, 2010; Karabel, 2005; National Science Board, 2016; Oakes, 1990). Mathematics is often considered to be a gatekeeper in education due to its implications for future economic access and successful citizenship; this is especially true for minority students (Diamond, 2013; Moses & Cobb Jr., 2001;

Nasir & Cobb, 2002). The lack of representation in STEM and mathematics fields limits Blacks' capacity for legitimate democratic participation, upward social mobility and job security (Martin, 2000; Strayhorn, 2015).

PBIs and other Minority Serving Institutions face unique challenges because of the population of students they serve. Existing studies on persistence among underrepresented minorities in STEM degree programs often focus on currently enrolled students, or students who attended Predominantly White Institutions (Price, 2010; Russell & Russell, 2015; Strayhorn, 2015). For this reason, it is important to examine the topic more thoroughly by incorporating the perspectives of successful Black and African American graduates, and those who attended less selective institutions as nontraditional students. Colleges and universities that enroll Black and African American students pursuing STEM and mathematics degree programs will benefit from the new knowledge gained from this study.

Statement of Purpose

The purpose of this study was to explore the challenges and opportunities associated with building and sustaining a successful mathematics degree program committed to access and excellence at an under-resourced PBI. Concurrently, the study examined and documented the experiences of the graduates from one of these programs by means of in-depth interviews. The interviewing process followed the Seidman (2013) phenomenological model: three 60- to 90-minute interviews focused on life history, the college experience, and a reflection on the meaning of that experience. I used these stories and reflections to explore factors associated with persistence and success in earning the mathematics degree, and to address the research questions from this study.

Research Questions

The primary research question guiding this study was: What are the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution? This study also addressed the following sub questions:

- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their life and schooling experiences?
- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their undergraduate experiences?
- What factors do Black women and men who have earned their degree in mathematics from an under-resourced PBI perceive to be associated with success in earning the mathematics degree?

Background and Context for the Study

The study site was the Mathematics Department at Clementa Pinckney College[2] (CPC), an accredited, regional, four-year, Predominantly Black Institution located in the eastern United States. CPC offers a range of associate and baccalaureate degree programs rooted in the liberal arts including business, STEM, education, and nursing.

Regional colleges are often under-resourced because they compete with more selective institutions for state funding and attention (Bowen, Kurzweil, & Tobin, 2005). State-based aid for CPC was reduced by more than 20% between 2008-2012 due to

[2] Clementa Pinckney College is a pseudonym. The late South Carolina Senator Clementa C. Pinckney was among the victims of a racially motivated mass shooting in Charleston in 2015. Reverend Pinckney spent his career as a political activist and a minister promoting social justice in his community. Pinckney's maternal family has roots in the Civil Rights movement, and his paternal family is possibly descended from people who were enslaved by one of the original framers of the U.S. Constitution.

legislative cuts for public institutions, while enrollment at the college remained steady. CPC was allowed to increase tuition by $300 per year during that time, but this fell short of the resources needed to maintain the necessary personnel, facilities, and tools to support students who might be "closer to the margin of attending college" (Bowen et al., 2005, p. 211). CPC is located in one of 32 states that has transitioned toward funding policies and formulas based on student outcomes and institutional performance rather than student enrollment (National Conference of State Legislatures, 2015). Because public higher education institutions receive more than one-third of their funding from state governments, these policies can have a profound impact on marginalized students of color and the institutions that serve them (Bowen et al., 2005; Jones, 2015). As a Predominantly Black Institution, CPC qualifies for and has received federal competitive grants and formula funds through the U.S. Department of Education. These programs are designed to support PBIs in establishing or strengthening academic programming in order to serve low- and middle-income Black Americans and to expand higher education opportunities for those students (New America, 2015; U.S. Department of Education, 2016b, 2017). These funds have been vital in providing upgrades to academic facilities at CPC, however the college remains under-resourced in terms of teaching and counseling capacities.

Predominantly Black Institutions face similar challenges to Historically Black Colleges and Universities (HBCUs) and other Minority Serving Institutions, since these colleges primarily enroll low-income, first-generation students who are academically underprepared for college coursework (New America, 2015). While all higher education institutions must dedicate resources toward effective instruction in order to impact course

completion, transfer rates and number of degrees awarded, PBIs must also dedicate resources toward equity, access, and supportive college experiences due to the barriers their students experience (Jones, 2015). Under-resourced colleges and PBIs encounter the highest risk of student dropout and *stop-out*, referring to students who drop out and then re-enroll, due in part to the aforementioned factors (Bowen et al., 2005; Jones, 2015; New America, 2015). Overall graduation rates at PBIs are below 20% and graduation rates for African-American students at PBIs average 15%. Retention rates are generally just over 50% between the first and second year of college (New America, 2015).

As a regional college, CPC recruits many of its students locally and has an open admissions policy (Bowen et al., 2005). A substantial proportion of CPC students are nontraditional students, which means they (1) have one or more dependents, (2) are single caregivers, (3) do not have a traditional high school diploma, (4) delayed postsecondary enrollment, (5) attend school part time, (6) are employed full time, or (7) are independent for financial aid purposes (Radford et al., 2015). While nontraditional students comprise up to 74% of all undergraduate students, those with more than one nontraditional characteristic are more likely to attend for-profit colleges, community colleges, or two-year degree programs (Brock, 2010). Nontraditional students can be more vulnerable to challenges that might affect their well-being, stress-levels, and likelihood of persisting and attaining a degree (Markle, 2015; Radford et al., 2015).

CPC provides student services and resources geared toward college access and success, and it seeks to provide a supportive campus climate. The college offers academic preparation programs designed to promote college success in mathematics, literacy, and non-cognitive skills; remedial classes; academic and career counseling; and

on-campus daycare for students' children. CPC does not provide campus housing. However, the college hosts a variety of clubs, organizations, leadership programs, and community engagement opportunities, as well as mens and women's athletic and intramural teams in order to engage students in campus life.

The Mathematics Department, which seeks to offer an intellectually rigorous and engaging curriculum that promotes critical thinking and emphasizes problem solving, is housed within one of four schools at CPC. The school enrolls roughly 40% of CPC students, and contains degree programs in mathematics and several science, technology, and health sciences disciplines. The Mathematics Department offers developmental coursework, free mathematics tutoring, and opportunities for students to participate in mathematics clubs and commumity engagement programs. During the 2015-2016 academic year, 46 students were enrolled in the mathematics major at CPC. The Mathematics Department was established in 2000, and between 2005-2015 the department awarded 41 baccalaureate degrees in mathematics. Thirty-two of those degrees were awarded to Black students.

Given the challenges confronted by under-resourced regional colleges and Predominantly Black Institutions, combined with the vulnerabilities faced by non-traditional students, the persistent academic disparities for Blacks and African Americans and the daunting structural challenges this presents, along with the gross underrepresentation of Blacks in mathematics degree programs, the relative success of the Mathematics Department at CPC is remarkable. This study documents the stories of four graduates of the mathematics degree program at CPC, and uses these stories to

explore opportunities for building and sustaining a successful mathematics degree program at an under-resourced PBI.

Overview of Methodology

To address the research questions, I conducted an interpretive case study of four successful Black mathematics degree-holders from a specific PBI. Each graduate was viewed as a unique case, and findings were reported in the form of stories and themes. Because I wanted to understand the experiences and perspectives of successful Black graduates, purposeful sampling was employed to select participants for this study. Participants were recruited from a pool of 32 recent graduates from the mathematics degree program at the research site, and subsequently invited back to the CPC campus for three in-depth, phenomenological interviews (Seidman, 2013). During these semi-structured interviews participants shared their stories, reflections, and perspectives on life experiences and college experiences, and the meaning of those experiences as they pertained to successful completion of the mathematics degree program. Guided by the literature on persistence and retention among African American STEM and mathematics students, I sought to understand these graduates' experiences and their beliefs about their own persistence and success with the mathematics degree.

Interview data was collected over a three-week period in July 2015. After transcribing the interviews, I used coding strategies discussed in Creswell (2013). In addition, I used *nVivo* qualitative software to assist in data organization, analysis, and retrieval. These strategies included beginning with a start list of codes developed from my literature review, which were adjusted, expanded, and refined as I worked through the interview transcriptions to develop categories. These categories served as the basis of

themes and assertions. During this process, I returned to the individual cases to construct participant profiles, which took the form of counternarratives. Throughout the process, I employed credibility and trustworthiness warrants to ensure the quality of the findings.

Rationale and Significance

This study contributes to the literature on persistence and retention of African American students in mathematics. The literature is replete with studies focused on the challenges of recruitment, retention, and graduation of African Americans in the STEM disciplines at Predominantly White Institutions, and persistence factors from the perspectives of currently enrolled students (Price, 2010; Russell & Russell, 2015; Strayhorn, 2015). However, there exist few such studies from the perspective of successful African American college graduates or that take place at Predominantly Black Institutions. There exist even fewer studies specific to African American students in mathematics. This is significant because roughly 10% of Blacks enrolled in college were enrolled at HBCUs in 2014, and HBCUs awarded 15% of the bachelor's degrees Blacks earned in 2013-2014 (Beasley, Chapman-Hilliard, & McClain, 2016; National Center for Education Statistics [NCES], 2016). HBCUs also produced nearly one-third (31.4%) of the African Americans who earned doctoral degrees in science and engineering between 2004-2008 (U.S. Commission on Civil Rights, 2010). In addition, many existing Black mathematicians began their mathematics studies at HBCUs before earning their doctoral degrees from Predominantly White Institutions (Williams, 2008). Similar data does not exist with regard to PBIs. However, PBIs and HBCUs serve similar populations and face similar challenges; subsequently both designations are eligible to receive federal funding under the Higher Education Act of 1965 (New America, 2015; 20 U.S.C. § 1067q).

This study also highlights successes from a segment of the population whose celebrations and testimonies are historically and still too often unrecognized, unacknowledged, overlooked, or discredited. Black mathematicians who have earned a doctoral degree share a lineage one might compare to ancient Greek philosophers. Similar to the way history recognizes Socrates as Plato's teacher and Plato as Aristotle's teacher, current Black mathematicians record and maintain their educational ancestry in order to inspire and empower future generations. This educational ancestry is interwoven with biographical information, stories and testimonies, accomplishments, contributions to the field of mathematics, and links to peer-reviewed articles (Newell et al., 1980; Walker, 2014; Williams, 2008). These stories of strife, attainment, and ongoing perseverance are critical. It is vitally important to recognize, acknowledge and share these paths to excellence not only for future generations of Blacks and African Americans who benefit from having role models and exemplars of the same race, but also for educators like myself who work with Black and African American students (Ladson-Billings, 2009; Newell et al., 1980; Picower, 2009; Walker, 2014). Findings from the present study will both draw from and add to the stories and testimonies of successful Black and African American mathematicians.

Role of the Researcher

I first became acquainted with CPC through Dr. Alex Phillips[3], a Black mathematician who has dedicated much of his personal and academic career to building and bridging mathematics communities for those living in some of the most oppressed and socially impacted areas. Dr. Phillips is a number theorist and a mathematics

[3] This is a pseudonym.

educator; he is currently the Dean for the school of Mathematics, Science and Technology at the research site. His connection with CPC began years ago as a graduate teaching fellow in the 1990s. Dr. Phillips was a full-time faculty member from 2000 until 2007, when he left to finish his dissertation and pursue other professional opportunities before he returned to CPC in fall 2015.

Dr. Phillips and I met in fall 2013. We collaborated on a *CPC Community Outreach* study in early 2014, and through that study I developed an understanding of the CPC neighborhood, the community stakeholders, the Mathematics Department, and their mission. The *Community Outreach* study contained Skype interviews with CPC Mathematics Department members including students, graduates, and faculty. I had the privilege to meet some of those participants in person when I visited the research site in 2015 for the present study.

Dr. Phillips first conceptualized the *Telling Our Stories* project with another colleague in January 2014, and he requested my involvement as his graduate research assistant shortly thereafter. We worked together on the project until 2016, when Dr. Phillips encouraged me to complete the remainder of the study without him. We have remained in contact for the duration of the project.

Researcher Assumptions

As a long-time elementary school teacher in an urban district, I have had the opportunity to work with and learn from hundreds of students and families from various backgrounds. I have witnessed the generational impacts of systemic oppression and the achievement gap. Over the years I have been charged with employing dozens of instructional approaches and strategies, assessment protocols, and data analysis methods

in order to understand and transcend the disparities in educational outcomes. From these experiences, and the experience of working with various administrative and instructional teams, I have developed the following three assumptions regarding mathematical literacy, education outcomes, and human nature:

First, all people, regardless of racial, ethnic, or linguistic identity, and socioeconomic background, can learn mathematical concepts and become mathematically literate. Second, the achievement gap found in K-12 education and inherited by higher education is not simply a problem to be solved. The achievement gap is a symptom of the inequities caused by schools and schooling, which relate directly and indirectly to longstanding systemic, institutional disparities in societal and educational contexts. Third, implicit bias exists, and is operationalized intentionally and unintentionally through daily interactions and interpretations, through intellectual and behavioral expectations, and through opportunities afforded and withheld.

Definition of Key Terminology

The following definitions provide clarity in understanding the concepts and theories associated with this study.

Achievement gap. The achievement gap refers to a persistent disproportion in educational outcomes within the United States between White students and non-White students, socioeconomically advantaged students and socioeconomically disadvantaged students, monolingual English students and English language learners, and male and female students (Harding, Harrison-Jones, & Rebach, 2012; Ravitch, 2013).

African American/Black. African American and Black will be used interchangeably throughout this dissertation to "refer to individuals whose ancestral origins lie in groups

of African descent including African Americans, Africans, Haitians, West Indians, Black Caribbeans, among others" (Strayhorn, 2015, pp. 45–46). Black is capitalized as a proper noun concurrent with other panethnic designations such as Hispanic or Asian American (Crenshaw, Ocen, & Nanda, 2015).

Anti-Deficit Achievement Framework. An anti-deficit achievement framework for education research rejects the notion of traditional deficit-oriented inquiry that amplifies minority student failure in the education pipeline. An anti-deficit achievement framework integrates seamlessly with other theoretical frameworks because it predominantly informs the questions researchers ask. The primary purpose of an anti-deficit framework is to "better understand how students of color persist and successfully navigate their ways to and through various junctures" of the education pipeline (Harper, 2010, p. 67).

Attrition. Attrition refers to leaving a specific college, discipline of study, or degree program.

Critical Race Theory. Critical race theory (CRT) is a theoretical framework through which to examine and challenge the ways race and racism implicitly and explicitly impact social and curricular structures, practices and discourses (Yosso, 2002). CRT provides a way to understand how seemingly race-neutral structures in kindergarten through college education such as knowledge, merit, and objectivity actually help form and maintain the boundaries of White supremacy and racism. CRT can be used to deconstruct the meaning of *educational achievement*, and to provide the theoretical justification for oppositional *counterstories* that challenge educational assumptions from an outsider's perspective (Parker, Deyhle, & Villenas, 1999; Yosso, 2002).

Counterstorytelling. Counterstorytelling is an analytical framework used in critical race methodology. It is a method of telling the stories of people who are often overlooked in the literature, and as a means by which to examine, critique, and counter master narratives composed about people of color. Master narratives are dominant accounts that are often accepted as universal truths about particular groups, and such scripts implicitly convey assumptions about these groups according to negative stereotypes (Solórzano & Yosso, 2002).

Graduation. Graduation marks the successful completion of a high school or college study program, resulting in the attainment of a diploma or degree.

Historically Black College and University. An Historically Black College and University (HBCU), defined under Title III, Section 322a of the Higher Education Act of 1965 as amended, is an institution that was established prior to 1964 and whose primary mission was and is to educate Black Americans. To be designated as an HBCU, an institution must be accredited or making reasonable progress toward accreditation by a nationally recognized agency or one that is deemed reliable by the Secretary of Education (20 U.S.C. § 1061). Currently there are 100 designated public and private HBCUs, most of which are located in the southeastern United States (NCES, 2016).

Minority. The term racial or ethnic minority refers to any student or person who identifies as non-White. This includes Asian, Hispanic, Black, African American, Native American, and mixed ethnicity.

Nontraditional student. Many studies consider nontraditional college students to have one or more of the following characteristics: has one or more dependents, is a single caregiver, does not have a traditional high school diploma, delayed postsecondary

enrollment, attends school part time, is employed full time, and is independent for financial aid purposes (Radford et al., 2015). Independent students for the purposes of financial aid are aged 24 or older and students under 24 who are married, have dependents, are veterans or on active duty, are orphans or wards of the courts, are homeless or at risk of homelessness, or were otherwise determined to be independent by a financial aid officer (Radford et al., 2015).

Persistence. Persistence refers to a student's continued academic and social commitment within a specific college course, discipline of study, and/or degree program (Tinto, 1997).

Predominantly Black Institution. A Predominantly Black Institution (PBI), defined under Title III, Section 318b of the Higher Education Act of 1965 as amended in 2008, is an institution that (1) serves at least 1,000 undergraduate students; (2) has at least 50% low-income or first-generation degree-seeking undergraduate enrollment, (3) has a low per full-time undergraduate student expenditure compared with other institutions offering similar instruction; and (4) enrolls at least 40% African American students (20 U.S.C. § 1059e). Forty-nine distinct two- and four-year institutions have applied for and received formula grants under the federal PBI Program since its inception in 2010 (U.S. Department of Education, 2016b).

Recruitment. Recruitment refers to "broadening participation" with regard to a specific college, discipline of study, and/or degree program by increasing enrollment (Strayhorn, 2015, p. 45).

Retention. Retention means "increasing success" by preventing students from leaving a specific college, discipline of study, and/or degree program (Strayhorn, 2015, p. 45).

STEM. STEM is an acronym that refers to science, technology, engineering, and mathematics.

Organization of the Remainder of the Dissertation

Chapter 2 addresses the historical context and a review of the literature. The literature review discusses findings from existing studies on persistence factors, recruitment and retention for Black and African American students in STEM and mathematics degree programs. Chapter 3 presents the methodology. Components include rationale for research, research context and framework, sample and data sources, data collection methods, analysis methods, and issues of trustworthiness. The findings comprise chapter 4, and chapter 5 provides an analysis of themes. Chapter 6 presents a discussion and conclusion for the study as well as recommendations for future research.

Chapter 2: Historical Context and Literature Review

In this chapter, I present historical context and a literature review for the study. The primary research question guiding this study was: What are the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution (PBI)? Specifically, the study explored the factors associated with persistence and success in a mathematics degree program at an under-resourced PBI.

The historical context for this study presents a summary of statistics regarding Blacks and African Americans in science, technology, engineering and mathematics (STEM) professions, which supports the problem of gross underrepresentation of people of color in STEM fields and mathematics in particular. The section continues with data on college preparedness, enrollment, retention, and graduation among people of color compared with the general population, with the understanding that higher education inherits an achievement gap from the K-12 education system. The achievement gap is situated within a larger education trajectory for Black students, and this trajectory extends from preschool through undergraduate and graduate studies (P-20). The historical context then examines educational policies and practices within our socially and politically racialized society, which impact opportunities and outcomes for Blacks in P-20 American education.

Section two of this chapter presents the literature review for this study. The literature review synthesizes research on factors associated with persistence in college STEM and mathematics degree programs. In doing so, the review examines research on how students experience college socially and academically, citing relevant studies that feature the voices of high-achieving Black mathematics students who successfully navigated educational systems and overcame barriers. The literature review also examines institutional factors affecting retention among African American students, highlighting programs, partnerships, and other efforts designed to impact recruitment and retention in STEM and mathematics degree programs. The literature review features analyses of the existing trends and findings, noting that few to no similar studies exist concerning nonselective Predominantly Black Institutions and the voices of students who attend those institutions.

Section One: Historical Context

Mathematics is considered a gatekeeper in education because of its implications for future educational and economic opportunities (Moses & Cobb, 2001; Nasir & Cobb, 2002). A strong mathematics foundation is necessary for meaningful participation in a digital society and for global citizenship because mathematics is fully integrated into the world's industrial, technological, military, economic and political systems (D'Ambrosio, 2001; Gutiérrez, 2007; Gutstein, 2003; Moses & Cobb, 2001). Mathematics is also intrinsic to the arts and religions of modern civilization (D'Ambrosio, 2001). Unfortunately, too many minority and poor students fail to reach levels of mathematics and science literacy necessary even for knowledgeable participation in today's increasingly technological society (Oakes, 1990). With such a strong proportion of

minority and poor students failing to reach even basic levels of mathematical proficiency, the implications for their success in post-secondary mathematics degree programs are dire (Howard, 2010; Martin, 2000).

While mathematicians in the United States are generally a rarity compared with other science-related professions, Black mathematicians are practically nonexistent. One estimate shows that there are about 300 living Black mathematicians in the United States (Walker, 2014). Mathematicians work for federal, state and local governments and agencies, in colleges, universities, public and private schools, businesses, and industries (American Mathematical Society, 2017). They work in applied and pure mathematics fields including game theory, algebra, number theory, statistics, topology, and operations analysis. The work of mathematicians is both practical and critical for the sciences, engineering, technology, public policy, national security and many other domains essential to the nation's well-being (Walker, 2014).

Blacks and African Americans in Mathematics and STEM

Increasing the capacity of our nation's workforce in mathematics and other science-related fields has been a major policy initiative for decades. Doing so maintains America's status as a global competitor in an increasingly advanced economy, improves future science and technology innovations, and sustains the nation's homeland (National Science Board, 2016; Strayhorn, 2015). Whites represent 82.3% of the science, mathematics, and engineering workforce in the United States while Asian Americans encompass 10.4%. Blacks, Hispanics, and American Indians represent 3.4%, 3.1% and 0.3% respectively (Atuahene & Russell, 2016; Strayhorn, 2015).

If college degree attainment trends are any indication of future workforce trends, the aforementioned racial discrepancies will hold steady. Of the 588,952 U.S. citizens who earned a bachelor's degree in science and engineering in 2013, 62% were White men and women while 9% were Black (National Science Board, 2016). That same year, Blacks earned only 5.3% of the bachelor's degrees in mathematics. Between 2000 and 2013, Blacks earned just above 5% of the bachelor's degrees in mathematics in the United States (National Science Board, 2016). The underrepresentation of Blacks in mathematics degree attainment is even more pronounced with advanced degrees, as indicated in *Table 1* (American Mathematical Society, 2017; National Science Board, 2016). While the numbers show progress compared with the eight Blacks out of a total of 1,374 total people who earned doctoral degrees in pure mathematics before 1943 (Newell et al., 1980), Blacks remain grossly underrepresented in mathematics degree attainment relative to the general population.

Table 1: Mathematics Degrees Earned in the United States, *2000-2013*

Citizenship or race/ethnicity	Bachelor's	Master's	Doctoral
All groups	215,968	69,331	18,492
U.S. citizen or permanent resident	202,780 (93.8%)	42,085 (60.7%)	9,275 (50.1%)
White	145,551 (71.7%)	28,808 (68.4%)	6,876 (74.1%)
Black, Hispanic, Asian, or American Indian	44,671 (22.0%)	9.476 (22.5%)	1,558 (16.7%)
Black	10,919 (5.3%)	1,985 (4.7%)	274 (2.9%)

Notes. Racial and ethnic breakouts include U.S. citizens and permanent residents only. Master's and doctoral degrees earned include mathematics and statistics.

Source. National Science Board. (2016). *Science and engineering indicators 2016*. Arlington, VA: National Science Foundation (NSB-2016-1)

With such a profound disproportion in degree attainment between Blacks and the general population, and also between American citizens and non-citizens, it is easy to

understand why federal government policy and funding efforts focus not only on increasing the number of STEM degree earners, but also on diversifying that population. In fact, a 2012 federal initiative sought to increase the number of American STEM professionals by one million by the year 2022 (Committee on STEM Education [CoSTEM], 2013; President's Council of Advisors on Science and Technology [PCAST], 2012). That equates to an additional 100,000 degree earners per year. The initial plan included various measures targeting P-20 education with a specific focus on underrepresented minorities, noting that decreasing the attrition rate among minorities alone would significantly contribute toward the number of STEM graduates (CoSTEM, 2013). The initiatives focus primarily on engagement, preparedness and recruitment at the K-12 level, and on partnerships and retention efforts at the undergraduate level (CoSTEM, 2013; PCAST, 2012). Increasing the proportion of Blacks and other minorities in mathematics and STEM fields not only contributes to the number of people within those professions, but it introduces new and innovative ideas and perspectives to mathematics-based professions (Gutiérrez, 2007).

Lack of persistence in STEM degree programs has been a recurrent and ongoing concern, particularly for Blacks and students from low socioeconomic backgrounds. Data from the Beginning Postsecondary Student Longitudinal Study indicate that of all incoming college freshmen who declared STEM majors in 2004, nearly half had left college or changed majors by 2009 (Chen, 2013; National Science Board, 2016). Attrition rates varied across STEM disciplines, and across demographic and enrollment characteristics. The attrition rate for mathematics majors was 38%. More than 60% of Blacks left STEM majors, and nearly 65% of students who attended minimally selective

or open enrollment institutions left STEM majors (Chen, 2013). Students with lower high school grade point averages (GPAs) or fewer high school mathematics courses left STEM majors at a higher rate, as did those with lower income levels and whose parents had attained lower levels of education (Chen, 2013).

The numbers are both alarming and enduring (Bowen et al., 2005; National Science Board, 2016). A multinomial probit analysis revealed several possible correlating factors as potentially important to STEM attrition. Some of these factors included demographic characteristics, precollege academic preparation, institutional context, climate and support, and STEM-based course taking and performance (Chen, 2013). Other studies also suggest lower levels of preparedness for college level coursework and unsupportive campus climates and policies as possible reasons for low retention and success rates in STEM degree programs (Atuahene & Russell, 2016; Russell & Russell, 2015).

Data on College Preparedness, Enrollment, Retention and Graduation

The problem of low retention and graduation rates among Blacks and other minorities is not unique to STEM degree programs. Enrollment in two and four year colleges has increased across all subgroups of students (Bowen et al., 2005; Chen, 2013; National Science Board, 2016; Snyder & Dillow, 2015), but the six-year graduation rate for Black undergraduates entering college in 2005 was 39.9%, compared to 58.7% for all collegians (Snyder & Dillow, 2015). Even more concerning is the fact that roughly a third of all Black men who enter higher education leave altogether before completing their degree (Strayhorn, 2015). The differential in degree attainment rates between Blacks and other races has persisted for more than half a century (Bowen et al., 2005).

Enrolling in college and completing a degree are huge milestones for many young adults (Bowen & Bok, 1998). Aside from the potential long-term benefits of college attendance and completion such as career options, increased income and upward mobility (Contreras, 2011), there are also potential societal benefits such as reducing the burden on social service agencies and the criminal justice system and producing a more educated society that is prepared for democratic citizenship (Katsinas & Bush, 2006).

Although completion of an undergraduate college education is important from both the perspective of the individual and society, many prospective college students lack the skills and the resources they need to enter college or to complete a college degree (Handel & Williams, 2011). Of the students who enrolled in postsecondary education in 2000, more than 25% took at least one remedial course (Handel & Williams, 2011), and data from the National Education Longitudinal Study (1988-1994) suggest that only half of low-income high school graduates were academically prepared to attend four-year colleges or universities (Bowen & Bok, 1998). The U.S. Department of Education reports that 98% of public community colleges, 80% of public four-year colleges and universities, and 59% of private institutions offer remediation (Handel & Williams, 2011).

These high rates of remediation paired with low rates of undergraduate completion suggest that despite the fact that high school students' college aspirations have been on the rise, significant gaps remain in college readiness, access, and success across race, ethnicity, and income groups (Roderick, Nagaoka, & Coca, 2009). Those who face some of the greatest barriers to pursuing a postsecondary education often include young adults

from low-income families, first generation college students, and minority students (Atuahene & Russell, 2016; Contreras, 2011).

Nationwide at the K-12 level, African-American and Hispanic students historically have higher suspension, expulsion and drop-out rates and lower high school graduation rates than White and Asian American students (Crenshaw et al., 2015; Howard, 2010; Jackson, 2015; Massey, 2007). According to the 2008 report "Given half a chance: The Schott 50-state report on public education and African American males," more than half of Black males nationwide did not receive high school diplomas with their cohorts in 2005-06 (Jackson, 2008). According to the Schott Foundation's 2015 report, 59% of Black males graduated with their cohorts in 2012-13, which marks a significant increase. However, the graduation disparity between Black and White males widened, increasing from 19 percentage points in 2009-10 to 21 percentage points in 2012-13 (Jackson, 2015). In addition, nine of the 10 lowest performing urban school districts showed Black male graduation rates of less than 30% for the 2012-13 school year. That was not a typographical error. Fewer than 3 out of every 10 Black males graduated high school on time in 9 American urban school districts (Jackson, 2015). This is deeply concerning since the majority of Black students are enrolled in large, under-resourced urban school districts across the nation (Atuahene & Russell, 2016; Byrnes, 2003; Jackson, 2015).

Policies, Practices, and Unequal Outcomes

The data reflecting Black and African American students' experiences in American education is difficult to process. They yield vast questions about why these trends and trajectories exist in the first place, and what scholars and educators can do to disrupt this cycle. The explanation is complex, and it lies somewhere within the deeply entrenched

patterns, policies and practices that have built and sustained this system that has failed so many. Interestingly, the achievement gap has persisted and sometimes widened over time, despite the existence of policies designed to prevent and improve these exact disparities in educational outcomes.

The first major national policy initiative, the Elementary and Secondary School Act of 1965 was enacted to address unequal education opportunities and outcomes along socio-economic lines (Wilson, 2006). New and subsequent federal policies have been legislated by nearly every presidential administration to address resource allocations, teacher quality, academic standards for instruction, school and district accountability and student performance (Snyder & Dillow, 2015).

Despite decades of federal policies designed to address and regulate teacher quality and educational opportunities, mathematics teachers with out-of-field degrees remain prevalent in high poverty communities at both middle schools (37%) and high schools (13%) according to descriptive data derived from the nationally representative 2011-12 Schools and Staffing Survey (National Science Board, 2016). Even with heightened standards, recommendations, and competitive grants focused on achievement and accountability, students from marginalized identities and communities continue to underachieve compared with their White, middle-class counterparts according to both standardized assessment data and in-school factors such as retention rates, drop-out rates and advanced course enrollments (Howard, 2013; Milner, 2013; Nasir & Cobb, 2002).

Some of the starkest contrasts exist among Black students. Data from the 2007 Programme for International Student Assessment (PISA), which compares mathematics achievement among developed nations, revealed that 15-year-olds from the United States

ranked 25 out of 30 developed nations in mathematics literacy and problem solving (Baldi et al., 2007). However, disaggregated PISA results show that when looking at only White achievement the United States would rank among the top nations. Conversely, when looking at only minority achievement the United States would rank near the bottom (Berliner, 2006). Other studies show that Black students are less likely to enroll in Advanced Placement courses or to participate in gifted programming, they are more likely to be classified as students with disabilities, and more likely to be suspended or expelled (Jackson, 2015). Black girls in particular have been stereotyped as hypersexual and fixated on social rather than academic pursuits. Statistically they are subjected to higher degrees of school discipline and lower degrees of protection from harm within the public school system (Crenshaw et al., 2015). Black male students have been stereotyped as violent, unfocused and unpredictable, and they too have been subjected to disproportionate levels of discipline and differential treatment in school (Howard, 2013; Jackson, 2015). Disaggregated data on school success and discipline rates from the 2013 Office of Civil Rights Data Collection confirm the historic and pervasive existence of racist structures and oppressive practices throughout the American public school system (Archbald & Farley-Ripple, 2012; Joseph, Viesca, & Bianco, 2016; Oakes, 1990; U.S. Department of Education, 2016a).

Systemic Inequality, Deficit Frameworks, and Racism

It is tragic that such a huge proportion of students are underserved and undereducated in a country that promotes education as a tool for social and economic mobility. Even more disturbing is the fact that so many policymakers and educators are not outraged that the discrepancies have consistently fallen along socioeconomic, racial, ethnic, and gender

lines since at least the 1970s according to data from the National Assessment of Educational Progress (Howard, 2010; J. Lee, 2012; Lubienski, 2008; McGraw, Lubienski, & Strutchens, 2006; NCES, 2011).

From an educational policy and practices perspective the achievement gap is thought to be embedded in the context of higher academic demands due to society's changing needs and expectations for education, combined with a population that is shifting toward a greater proportion of minorities, immigrants, and people with lower socio-economic status (Wilson, 2006). The literature is replete with studies of instructional practices and approaches and their effects on student achievement (Baker, Gersten, & Lee, 2002; Gersten et al., 2009; Griffin, League, Griffin, & Bae, 2013; National Mathematics Advisory Panel [NMAP], 2008). While such studies seek to inform educational practices and programming, the same studies might offer a static depiction of social inequities and student identities (Flores, 2007; Gutiérrez, 2008; Hilliard, 2003). Gutiérrez (2008) maintains that mathematics achievement gap studies "allow researchers to talk about, and unconsciously normalize, the 'low achievement' of Black, Latina/Latino, First Nations, English language learners, and working class students without acknowledging racism in society or the racialization of students in schools" (p. 359). By citing factors such as attitudes of students towards the institution of school, cultural and linguistic knowledge that students bring from home and their communities, and educational and economic resources available in the community, some studies and analyses implicitly place blame on the students and communities themselves (Harding et al., 2012; Howard, 2010; J. Lee, 2012; Nasir, Snyder, Shah, & Ross, 2012; Shapiro, 2005).

In truth, the most salient explanations for the achievement gaps transcend the realm of schools and schooling. Amidst the formalized concept of "equal treatment" under state and federal education laws including nondiscrimination policies, special education law, desegregation law, state finance policies, and school admissions policies, "there are many critical junctures where opportunity allocating decisions occur beyond the controls of policy" (Archbald & Farley-Ripple, 2012, p. 35). The most carefully written policies cannot and do not address systemic stratification and racism. Nieto (2010) would argue that all systematic policies about standardization, curriculum selection and delivery, and testing reveal and reinforce the ideological biases that exist in the United States. In education, as in society, rewards and privileges are distributed according to race, class, gender, and other socially constructed differences and so schools "reproduce fairly consistently the inequalities that exist in society" (Nieto, 2010, p. 54).

Tyack (1995) noted that despite the collective historical policies and strategies implemented with the goal of creating a "common good" or "mainstream culture" (p. 27) within our education system and society, there still exist inequalities in wealth, power, and prestige. Drawing from the history of power structures and the processes of Americanization, Tyack (1995) stated that "attempts to preserve White supremacy and to achieve racial justice have fueled the politics of education for more than a century" (p. 4). One historic example is the eugenics movement, which took root in the United States in the early 1900s. The eugenics movement suggested a hereditary basis for intelligence and morality and thus drove the popular thinking of the 1920s and 1930s based on biological determinism, White superiority and subsequent racial inferiority (Howard, 2010). At the time, African American and Hispanic students were explicitly denied

access to mainstream American society and were forced to attend underfunded, segregated schools (Ravitch, 2000). Some scholars draw a connection between the early and flawed ideas about racial inferiority and contemporary educational outcomes, outlining how these beliefs and behaviors now appear in the form of lower expectations, inequitable funding for schools attended by students of color, and exclusion from enriched academic programming (Howard, 2010; Kozol, 2012; Massey, 2007).

A longstanding remnant of the eugenics movement is the prevalence of deficit-based thinking. Deficit-based constructions of underachievement imply that poor academic performance is rooted in students' perceived cognitive and motivational deficits, suggesting that students of color and students from low-income backgrounds suffer from intellectual deficiency, poor command of Standard English, and/or a 'culture of poverty' (Castagno, 2008; Gildersleeve, 2010; Howard, 2010, 2013; Picower, 2009). This perception that marginalized students are cognitively, culturally or linguistically deficient reproduces and justifies Whiteness as the ideological norm against which students of color are measured (Hilliard, 2003; Picower, 2009). Deficit-based thinking manifests itself through hidden assumptions, differential instructional approaches, assessment practices and course-placement decisions, and the silencing of marginalized student voices in school contexts (Archbald & Farley-Ripple, 2012; Castagno, 2008; Cobb & Russell, 2015; Lubienski, 2007; Picower, 2009). The existence of teachers and educators who lack critical consciousness, combined with institutional factors such as second generation segregation, teacher quality, tracking in integrated schools and teacher distribution across tracks (referred to as teacher tracking), lowered academic expectations, and inequitable school discipline policies and practices have had lasting and

profound effects on academic outcomes for marginalized students (Archbald & Farley-Ripple, 2012; Berends & Peñaloza, 2010; Brooks, Arnold, & Brooks, 2013; Darder, 2012; Diamond, 2013; Picower, 2009).

High school graduation is the "end point in a twelve-year educational career where inequities are most visible to the public, to educators, and to students themselves" (Archbald & Farley-Ripple, 2012, p. 49). Still, data from the Early Childhood Longitudinal Study (ECLS), a nationally representative, longitudinal study of child development, early learning, and school progress, shows that the achievement gap in mathematics begins before kindergarten. Results from a mathematics assessment administered to kindergarten students in fall 2010 varied by demographic characteristics including race/ethnicity, socioeconomic status, and parent education (National Science Board, 2016). Similar findings have been used to confirm deficit-based theories by citing family factors such as access to books and libraries, lower level of language mastery, social and communication skills (Wilson, 2006), but the initial ECLS findings also point toward external societal factors as an explanation for the achievement gap.

Historic and contemporary patterns of inequality such as the racial income gap, the racial wealth gap, suburbanization and redlining have contributed to structural inequalities outside of schools (Diamond, 2013; Massey, 2007). These differences in wealth combined with social factors including health care, nutrition, and access to quality childcare can have further implications on educational opportunities and outcomes due to their effects on overall physical and mental health, attendance, and cognition (Ravitch, 2013). Testing practices also perpetuate the cycle of inequality because of structural resource allocations based on test scores and other accountability measures (Diamond,

2013; Howard, 2010; Milner, 2013). Results-based resource allocations can lead toward reduced access to material and digital resources, high-quality instruction, advanced placement courses, enriching environments, and extra-curricular activities for students in the poorest communities. In turn, these students have fewer opportunities for educational experiences, mentors and skill development (Archbald & Farley-Ripple, 2012; Jackson, 2015; Milner, 2013; Oakes, 1990; Wilson, 2006).

The complex and dynamic social structures that exist within and beyond schooling and learning prompt some scholars to conceptualize minority students' underachievement as a lack of opportunity (Lee, 2012; Milner, 2013; Wilson, 2006). These scholars reject the perception that the profoundly unequal outcomes exist due to differing backgrounds, attitudes, abilities or ambitions, stating that such positions reinforce the ideology of intellectual inferiority (Hilliard III, 2003; Howard, 2010; Martin, 2000). These perceptions and structural inequities continue through the higher education system, where Black college students across disciplines experience lower acceptance and enrollment rates, and frighteningly high stop-out and dropout rates (Snyder & Dillow, 2015; Strayhorn, 2015).

Historical Policies, Practices, and Trends in Higher Education

Similar historical policies, practices and outcomes have pervaded the higher education system in terms of access, opportunities, and experiences. Comparable to the public K-12 school system, American colleges and universities were initially established to benefit and educate the dominant culture (Winkle-Wagner, Sulè, & Maramba, 2014). Early private institutions enforced admissions and enrollment policies to support their respective mission statements, which implicitly favored White, male, academically

prepared applicants who could afford the tuition (Karabel, 2005). The Servicemen's Readjustment Act of 1944, more commonly referred to as the G.I. Bill, sought in part to increase college opportunities for less wealthy students. The G.I. Bill (1944) gave White veterans with interest and ability the resources to attend college, but Black veterans were excluded from these resources because they had been educated in separate but unequal secondary schools (Massey, 2007). Those who could attend college found that their separate higher education institutions were drastically underfunded and lacked resources for students (Bowen et al., 2005).

Around that time, Herman Marion Sweatt, a Black veteran, was denied admission to the University of Texas-Austin School of Law. He filed a lawsuit claiming that this denial was an infringement of his equal protection rights because at the time there existed no separate law school for Blacks in Texas. The Texas 126th District Court ruled that UT-Austin School of Law would not be required to accept Blacks if the Board of Regents created a separate university law school. When the new university opened, Sweatt did not attend due to inferior quality. However, the Texas Supreme Court refused to rehear his case, so the National Association for the Advancement of Colored People (NAACP) filed Sweatt's case at the U.S. Supreme Court (Heilig et al., 2010). In *Sweatt v. Painter* (1950) the court ruled that the educational opportunity for Black and White law students was not "substantially" equal to meet the equal protection clause under the Fourteenth Amendment and ultimately the UT-Austin School of Law was required to admit Sweatt (Heilig et al., 2010). While this ruling was not pivotal for Blacks' equity and access to higher education opportunities, its existence further demonstrates the racist foundation upon which our P-20 education system was built.

The foundational *Brown v. Board of Education* (1954) U.S. Supreme Court decision overturned *Plessy v. Ferguson* (1896) and essentially changed education in America by declaring segregation "inherently unequal." This decision prompted desegregation in 17 states and sought to facilitate more culturally diverse learning environments for K-12 students. Concurrently, many colleges and universities with separate public colleges for Black students were required to desegregate. Upon pressure from the John F. Kennedy presidential administration, some colleges also implemented voluntary affirmative action to help integrate learners (Karabel, 2005). Affirmative action in education is a policy of recruiting and admitting members of historically marginalized groups, and it often results in admitting students who otherwise would not be accepted (Grodsky & Kalogrides, 2008).

In subsequent decades, colleges have established admissions quotas, affirmative action, and other race-conscious policies and practices to increase access to higher education and to promote increased diversity on campus (Grodsky & Kalogrides, 2008). During the 1990s several states outlawed the consideration of race in admissions policies through Civil Rights Ballot Initiatives, and in 1996 the State of Texas passed the Top Ten Percent Plan, which turned toward a high school ranking system to ensure diversity at state-funded universities (Bowen & Bok, 1998; Heilig et al., 2010).

Meanwhile, federal judicial decisions have demonstrated a fluctuating stance on race-conscious college admissions policies (Kim, 2005). The *Regents of the University of California v. Bakke* (1978) U.S. Supreme Court decision forbade the use of rigid quotas in college admissions processes and the *Hopwood v. Texas* (1996) U.S. Court of Appeals decision ruled that race cannot be used in college admissions. The *Grutter v. Bollinger*

(2003) U.S. Supreme Court decision overruled the *Hopwood* (1996) decision and affirmed racial diversity as a compelling interest for universities. However, the *Grutter* (2003) decision permitted affirmative action as just one factor among many in a holistic admissions process. The *Fisher v. University of Texas* (2013) U.S. Supreme Court decision reinforced the *Grutter* (2003) decision, sustaining the limited use of affirmative action in college admissions policies. Just one year later the *Schuette v. Coalition to Defend Affirmative Action* (2014) decision declared Michigan's ban on affirmative action constitutional.

While the aforementioned policies, provisions, and judicial decisions may have impacted campus admissions practices, minorities continue to experience unequal access to resource-rich higher education institutions (Kim, 2005). Black and Hispanic individuals represent 33 percent of the college-age population in the United States, and yet they represent just 14 percent of students at the 468 most selective 4-year colleges (Association of American Colleges and Universities [AACU], 2015). It is important to note, however, that enrollment rates do not always reflect acceptance rates. Additionally, the demographic breakdown of students who are admitted to a college depends on the applicant pool (Bowen & Bok, 1998). One misconception that exists is that colleges have enough applicants to be able to pick and choose among those applicants. In fact, the majority of undergraduate institutions across the nation "accept all qualified candidates and thus do not award special status to any group of applicants, defined by race or on the basis of any other criterion" (Bowen & Bok, 1998, p. 15). Still, research suggests that Blacks who do attend selective colleges and Predominantly White Institutions (PWIs) often experience negative campus climates, which presents a barrier to social and

academic success (Davis et al., 2004; Joseph, Hailu, & Boston, 2017; Osborne & Walker, 2006; Solórzano & Yosso, 2000).

Blacks and Hispanics also represent 36 percent of students at open-access two- and four-year colleges in the United States (AACU, 2015). These community colleges and less-selective 4-year institutions where low-income students and students of color are most likely to enroll typically have fewer resources, more students, and markedly lower spending per student than the resource-richer institutions where most White students enroll (AACU, 2015; Chen, 2013). Predominantly Black Institutions (PBIs) and other Minority Serving Institutions statistically enroll the students who are least academically prepared for college and most vulnerable to the challenges that can affect their well-being, stress- and satisfaction-levels, and likelihood of persisting and attaining a degree (New America, 2015; Radford et al., 2015; U.S. Commission on Civil Rights, 2010). These institutions must therefore dedicate their limited resources not only to high-quality instruction, but also toward college access and supportive college experiences (Jones, 2015).

Community colleges, PBIs, and other Minority Serving Institutions have higher rates of remediation and markedly lower retention rates than private institutions and colleges with selective admissions processes (Bowen et al., 2005; Jones, 2015; New America, 2015). One federal report notes that an alarming 14% of those who entered Community Colleges with a STEM major were still STEM majors at their last point of enrollment (National Research Council and National Academy of Engineering, 2012). This statistic encompasses both graduates and those who stopped out or dropped out. Some scholars suggest that these same higher education institutions are charged with repairing the

inequities that pervade the American education system (AACU, 2015; Preston, 2017). Community colleges and other less-selective colleges potentially have the greatest impact since they enroll the highest proportion of nontraditional students and minorities.

Success Within a Failing System

I presented the historical context because it is important to understand the systems and structures from which so many of our Black students and scholars emerge. Participants from this study graduated from an under-resourced regional college, which was situated in a community where people might be impacted by any or all of these schooling, institutional, social, or societal constructs. However it is particularly important to recognize that within the grave statistics on student educational outcomes, mathematics success among African-American students is not only attainable, but success exists.

These successful Black mathematics graduates and highly gifted Black mathematicians emerge from the same sets of social conditions and school contexts that are traditionally assumed to produce only failure (Martin, 2000). Success is absolutely not determined by social context, family background, school climate, or teacher attitude. And yet, sadly, successful Black students and scholars are considered to be exceptions or outliers in our society that holds Whiteness as the ideological frame of reference (Ladson-Billings, 2009; Martin, 2000; Perry, 2003; Picower, 2009).

As scholars, we must be willing to find exemplary practice and successful students in communities that are too often dismissed as incapable of excellence (Ladson-Billings, 1995; Martin, 2000). Successful Black students can and do respond effectively to oppressive social conditions by adopting strong personal, academic and mathematics

identities (Martin, 2000), but to do so they must be able to see their intelligence as expandable (Steele, 2003). This realization can counteract the theory of intellectual inferiority because by forming academic identities, Black students can resist or oppose what they perceive as negative or as obstacles that stand in the way of their goals (Martin, 2000; Steele, 2003). In the next section, I present a review of the relevant literature on persistence factors and success among Black and African American students in STEM and mathematics undergraduate degree programs.

Section Two: Literature Review

Because the P-20 education system has been built on and perpetuated by implicitly and explicitly racist policies and practices, Blacks and African Americans must navigate these contexts throughout their schooling experiences (Bonilla-Silva, 2001; Howard, 2013). These contexts are rife with social, institutional, and educational barriers to success (Nieto, 2010). It is extremely important to consider the experiences and perspectives of those who successfully complete undergraduate STEM and mathematics degrees in order to understand ways the higher education system can counteract these policies and practices. This literature review will examine the factors associated with persistence in college STEM and mathematics degree programs. In doing so, the review will examine research on how Black students experience college socially and academically, citing relevant studies that feature the voices of high-achieving mathematics students who successfully navigated educational systems and overcame barriers. The literature review will also examine institutional factors affecting retention among African American students, highlighting programs, partnerships, and other efforts designed to impact recruitment and retention in STEM degree programs. The overall

trends and conclusions from existing research were used to inform the methods and methodology for this study, which explored factors associated with persistence and success in earning the mathematics degree at an under-resourced PBI.

Black Students' Persistence in College Mathematics

In his seminal work on undergraduate student retention, Tinto (1975) developed a theory on the college dropout process. The theory focused on the effects of social and structural integration on the interplay between goal commitment and institutional commitment (Tinto, 1975). Tinto (1997) later modified his theory to link classroom experiences with motivation and persistence. Findings from a mixed-methods study indicated that the existence of intentional classroom communities can be vital for students at commuter schools due to their implications for academic and social integration (Tinto, 1997).

Contemporary research shifts the perspective away from institutions and toward undergraduate students. While institutions aim to retain students and increase the proportion of students who graduate, students strive to persist and to complete a degree regardless of the institution from which it was obtained (Tinto, 2017). Tinto (2017) identifies sense of belonging, perception of curriculum, and self-efficacy as broad factors to persistence, but also recognizes the importance of family obligations, work, and financial concerns as factors that affect persistence.

Research on mathematics and STEM success among African American students generally cites the aforementioned factors and specifically delineates more nuanced social, cultural and personal influences (Palmer, Davis, & Maramba, 2010; Strayhorn, 2015). Interestingly, many of the same factors that are present for success in

mathematics and STEM majors are also absent for those who stop out, drop out, or change their majors. In a qualitative study of factors promoting academic and social success among underprepared Black male undergraduate students, Palmer, et al. (2010) found that the inability to identify with an academic-oriented community, the lack of mentorship, the lack of academic, social, or family support, and the lack of financial stability were reasons cited for leaving STEM programs. Other research indicates that some of these factors can differ between Black men and Black women, perhaps due to the particular and stigmatized ways they experience education and society (Crenshaw et al., 2015; Howard, 2013; Jackson, 2015; Joseph et al., 2017; Markle, 2015).

As with much educational research, it is difficult to isolate these variables and determine the extent to which each impacts persistence and retention in mathematics. It is also important to note that while a large proportion of existing research focuses on retention and persistence specifically in STEM-related fields of study, many of the same studies include participants pursuing mathematics majors. The following sections discuss the most prominent factors to persistence in mathematics and STEM fields, and they highlight findings from mathematics-specific studies as appropriate.

Social and Cultural Factors

In today's racialized education system, research suggests that society and culture play significant roles in how Blacks and African Americans persist and succeed in schooling and mathematics (Carr, 1996; Cobb & Hodge, 2002; Gutstein, 2003; Martin, 2006) In a stratified society such as ours, control of knowledge is intrinsic to hierarchical power (Bonilla-Silva, 2014; Massey, 2007). Dominant mathematics instruction in the United States privileges the Western frame of reference and makes sense of the world through

the views and perspectives of a relatively elite group (D'Ambrosio, 2001; Gutiérrez, 2007; Martin, Gholson, & Leonard, 2010; Moreno, Muller, Asera, Wyatt, & Epperson, 1999).

Research has been devoted to understanding the impact of multiculturalism and culturally relevant pedagogy in K-12 mathematics (Darder, 2012; Ladson-Billings, 2009). Findings suggest that when the pedagogical styles and instructional approaches used in mathematics classrooms align with the learning styles and everyday lives of minority students, these students flourish. Ladson-Billings (2009) discusses the educational practices of two teachers who were successful with African-American students by employing culturally relevant pedagogy. Characteristics of culturally relevant teaching include demonstrating care for the students, holding high expectations for all students, connecting the curriculum with students' community and everyday lives, and fostering a family-like environment in the classroom (Ladson-Billings, 1995, 2009; Tate, 1995b).

At the college level, similar characteristics with regard to classroom and campus climate have been associated with persistence and success for Black STEM and mathematics majors. A nurturing campus environment along with high academic expectations from faculty and peers can foster a sense of belonging (Borum & Walker, 2012; Palmer et al., 2010; Strayhorn, 2015) while differential academic expectations, negative assumptions and other microaggressions from both faculty and students can create feelings of academic and social isolation (Bir & Myrick, 2015; Fries-Britt, 1998; Markle, 2015; Solórzano & Yosso, 2000).

A strong academics-oriented identity has also emerged as an important factor to success in mathematics among Blacks and African Americans (Bir & Myrick, 2015;

Chang, Kwon, Stevens, & Buonora, 2016; Mehan, Hubbard, & Villanueva, 2008). However, some of the highest-performing Black high school graduates who attend PWIs drop out because they experience hostile, negative college environments due to discriminatory policies and practices, isolation, the perception among Whites that Blacks are less capable until proven otherwise, and simultaneous feelings of invisibility and supervisibility on campus (Borum & Walker, 2012; Davis et al., 2004). These experiences are both exhausting and disenfranchising on multiple levels, given that Blacks often feel academically defeated due to the prominent existence of unfavorable education trends and stereotypes around intellectual inferiority (Hilliard, 2003).

Steele (2003) and colleagues developed the theory of stereotype threat, which refers to "the threat of being viewed through the lens of a negative stereotype, or the fear of doing something that would inadvertently confirm that stereotype" (Steele, 2003, p. 111). Numerous studies have shown that when subjects take a test under the belief that they are being tested on their ability, those for whom there is a negative stereotype do worse than the other group. For example, on a verbal test, African Americans scored significantly lower than Whites because they thought the test was diagnostic of their intellectual ability. However, when they were told the test was to assess problem-solving skills, there was no significant difference in the performance of the two groups (Steele, 2003). Findings from the studies revealed that students with strong academic skills and identity were most affected by stereotype threat. Indeed, stereotype threat can cause the most academically successful students of color to withdraw from college (Osborne & Walker, 2006).

Research confirms that Black students who attend HBCUs often do not face the same hostile campus environments as those who attend PWIs due to racial homogeneity and a subsequent environment where minorities are encouraged and expected to excel academically (Palmer et al., 2010; Tatum, 2007). Tatum (2007) asserts that minorities benefit from a higher education environment that affirms identity, builds community, and cultivates leadership. Positive on-campus groups and communities at PWIs that affirm and support Black and academic identities may mediate the effect of hostile campus environments, and thereby disrupt academic disidentification and positively impact retention (Beasley et al., 2016; Fries-Britt, 1998). This is important because an increasingly large proportion of Black college students attend PWIs (Snyder & Dillow, 2015).

Although the aforementioned studies did not specifically look at campus climate at PBIs or at nonselective colleges, it is reasonable to expect similar findings with respect to social and cultural factors and their impacts on student persistence and retention in mathematics for the participants in the present study.

Affective Variables and Resilience Factors

Researchers have found that Blacks who attend PWIs lack psychological support systems that could help foster their persistence (Borum & Walker, 2012; Davis et al., 2004; Solórzano & Yosso, 2000), but there is also a body of literature that addresses the connection between resilience and academic success. Students who succeed in academic settings despite the presence of adverse conditions are considered to be educationally resilient (Williams & Bryan, 2013). Resilience refers to the "process of overcoming the negative effects of risk exposure, coping successfully with traumatic experiences, and

avoiding the negative trajectories associated with risks" (Fergus & Zimmerman, 2005, p. 399). This process, researchers argue, is a key ingredient to African American students' persistence and success in college (Kim & Hargrove, 2013).

The notion of educational resilience encompasses risk and positive adaptation (Kim & Hargrove, 2013). Resilient youth tend to take an active orientation to life, have an internal locus of control, seek out others for support, are involved in a greater number of positive activities, spend more hours on homework, and spend fewer hours in isolation (Blocker & Copeland, 1994). Getz (2000) explored how college students viewed their own sense of resiliency and its impact on their self-efficacy and success in higher education. Findings revealed that resilient students believed that difficult experiences made them stronger, and Getz (2000) concluded that resilient students were often self-efficacious in that they believed in themselves and their ability to succeed. Findings also revealed that the same students did not always feel embraced or understood on campus and thus they relied heavily on their strengths as resilient students to navigate the college experience (Getz, 2000).

Brown and Tylka (2011) found a strong correlation between racial socialization and resilience for African American college students who had experienced racial discrimination in the form of micro-aggressions and hostile campus environments. Racial socialization messages were discussed as race-conscious upbringing and education, cultural affirmation and cultural pride messages, as well as ideas for coping with racial hostility through spirituality or religion (Brown & Tylka, 2011). Because the most effective racial socialization originated with caregivers, results from this study had

implications for mental health professionals who work with African American families (Brown & Tylka, 2011).

Research also suggests the importance of psychological factors such as self-efficacy, self-motivation, and self-confidence specifically for African Americans pursuing STEM and mathematics degrees (Alkhasawneh & Hargraves, 2014; Bir & Myrick, 2015; Palmer et al., 2010; Strayhorn, 2015). In fact, there is a strong connection between the highest achieving Black mathematics students and high levels of self-efficacy and internal motivation (Ellington & Frederick, 2010). These findings underscore the importance of psychological and social support systems at PBIs and other college campuses that enroll the most vulnerable African American students, as some research suggests that resilience can be taught and nurtured in a supportive environment (McCreary, Cunningham, Ingram, & Fife, 2006). In addition, strong on-campus support systems might counteract the effects of stereotype threat and feelings of isolation, which are among the greatest barriers to resilience factors in higher education and STEM degree programs (Fries-Britt, 1998; Fries-Britt & Griffin, 2007; Osborne & Walker, 2006; Steele, 2003).

Educational resiliency will undoubtedly materialize as the participants from this study tell their stories. The participants graduated from an under-resourced regional PBI, which enrolls students who emerge from social and societal circumstances that are often thought to preclude academic success. Findings from this study will add another layer to the emerging body of literature about protective factors that contribute to childhood resilience for African American adolescents (Brooms, 2015; Williams & Bryan, 2013), and the already established body of literature about educational resilience as it relates to persistence among Black high-achieving college students (Ellington & Frederick, 2010;

Fries-Britt, 1998), Black males at PWIs (Davis et al., 2004; Harper, 2009), and HBCUs (Palmer et al., 2010; Strayhorn, 2015).

Academic Factors

Research shows that academic self-concept has a strong impact on outcomes for Black and African American college students (Strayhorn, 2015), and some studies have shown freshman grade point average (GPA) as a predictor for retention after the first year (Alkhasawneh & Hargraves, 2014; Beasley et al., 2016). In addition to GPA, some factors linked with academic identity formation and subsequent persistence in college mathematics include the availability of academic support or tutoring (Atuahene & Russell, 2016; Palmer et al., 2010) and faculty mentorship (Bir & Myrick, 2015; Chang et al., 2016). One study showed that for Black students attending PWIs, the greatest predictor of success in STEM degree programs was GPA while for Black students attending HBCUs the greatest predictor for success was faculty relationships (Strayhorn, 2015). This provides an interesting perspective on the ways Black students experience campus climate at each type of institution, and their apparent effects on academic identity formation and sense of belonging.

Regardless of institution, the presence of mentorship and role models can influence the decision to choose or remain in mathematics-related college paths in understated but significant ways. Research shows that Black and African American students are more likely to pursue college and career paths they believe to have ample future employment opportunities (Strayhorn, 2015), and Black mathematics students especially need Black role models so they might envision themselves as future mathematicians (Martin, 2000; Newell et al., 1980; Walker, 2014). Indeed, accessibility to role models and mentors

have been cited as reasons for staying in mathematics-related college majors (Palmer et al., 2010; Strayhorn, 2015). Mentorship in the form of hands-on learning opportunities and research experience opportunities can influence perceptions of relevance and the subsequent decision to remain in a mathematics- or science-related field of study (Chang et al., 2016; Fakayode, Yakubu, Adeyeye, Pollard, & Mohammed, 2014; Palmer et al., 2010).

Conversely, some of the greatest academic barriers to persistence and success in STEM and mathematics majors include inadequate academic preparation, negative faculty expectations, negative interactions with faculty and/or peers, lack of educational resources and support, and developmental or remedial education (Alkhasawneh & Hargraves, 2014; Atuahene & Russell, 2016; Bir & Myrick, 2015; Brock, 2010; Oakes, 1990). One of the most disenfranchising of these barriers to persistence is academic under preparation, especially for students who earned high GPAs in high school. High school completion does not always equate to college readiness, especially for students who attended under-resourced high schools (Conley, 2010). This can have a profound impact on academic self-concept for students who experienced success in high school only to be placed in remedial courses based on college entrance exam results (Howell, 2011).

Remediation has also emerged as a barrier to persistence, separate from but related to under preparation. While necessary for many, participation in remedial courses often slows academic progress due to subsequent temporal, financial, and instructional hitches. Remediated students enroll in and pay for classes that take time and effort, but do not count toward graduation requirements. In addition, remedial courses are often structured

or taught in a way that does not meet the needs of students because they seek to address deficits without understanding the students (Asera, 2001; Preston, 2017). Preston (2017) argues that students who have been placed in remediation because they struggle with mathematical concepts do not benefit from mathematics courses that are taught using traditional methods. Instead these students need more interactive, relevant approaches to mathematics. Studies also suggest that institutions must find ways to accelerate the pace of remedial coursework (Brock, 2010). This presents a challenge for institutions because remedial courses are funded at a lower rate and taught by less experienced faculty than traditional college courses (Handel & Williams, 2011).

Studies have also shown the existence of gatekeeping college courses for mathematics majors, referred to as "break" courses. Failure rates in gatekeeping courses such as Calculus I have a direct effect on attrition rates for students in mathematics majors (Worthley, Gloeckner, & Kennedy, 2016). As a young scholar and graduate student at Berkeley, Treisman (1992) sought to uncover reasons why several Hispanic and African-American students were unsuccessful in his college calculus class. These students performed poorly despite having strong academic backgrounds, family support, and a desire to learn calculus while his equally motivated Asian students succeeded in the course. In his landmark ethnographic study, Treisman (1992) found that Black students tended to study in isolation and were unclear of their course performance relative to classmates. Their Asian counterparts worked individually and in peer study groups, shared problem solving strategies, asked questions and compared answers with one another, and they always knew where they stood academically compared with classmates (Treisman, 1992).

Treisman (1992) ultimately used findings from his ethnographic study to design and develop the Emerging Scholars Program, which aimed to facilitate student success by incorporating peer-learning groups. Students initially volunteered to participate in the program and attended supplemental problem-solving workshops that ran parallel to calculus class sessions throughout the semester. During these sessions, small groups of students worked through challenging problems under the guidance and monitoring of graduate students (Hsu, Murphy, & Treisman, 2008; Treisman, 1992).

Treisman (1992) found that the African American and Hispanic students who participated in the Emerging Scholars Program outperformed students with similar academic backgrounds who did not participate in the program. The program's dramatic success was credited to students having the opportunity to work in peer support groups, to receive support and guidance from graduate students, and to engage in challenging mathematics problems. The Emerging Scholars Program was so successful that it became a model for similar programs throughout the country (Asera, 2001; Moreno et al., 1999).

Results of studies on the Emerging Scholars Program and similarly designed programs show that African American students who participate in these programs were retained at higher levels than non-participants (Hsu et al., 2008), outperformed similar students who did not participate in the program (Moreno et al., 1999; Treisman, 1992), and were more likely to persist in mathematics and science-related majors (Asera, 2001; Maton, Hrabowski, & Schmitt, 2000). Paramount to the research and efforts leading toward the Emerging Scholars Program was an intentional focus on academic excellence as opposed to simply passing the course, and the rejection of remediation as a solution

(Asera, 2001; Treisman, 1992). Missing from this body of work is an understanding, from the perspective of the students, of the particular aspects of the programs that made the most difference and why. While subsequent research has focused on student perspectives, it often centers on the highest-achievers who participate in similar scholarship programs or who excel despite unwelcoming campus climates (Ellington & Frederick, 2010; Fries-Britt, 1998).

These perspectives are undoubtedly important, but the voices of Black and African American students who succeed in mathematics majors without the aid of competitive programs, and those who do not attend highly selective colleges are equally important. The present study seeks to fill this important gap in the current research by helping researchers and institutions to better understand the perceived factors affecting the most vulnerable minority students. Because the study takes place at a nonselective regional college, which contains a substantial proportion of students who initially test into remedial courses or who fail gatekeeping mathematics courses despite having a strong academic background, it is reasonable to assume that academic factors would influence their paths toward graduation.

Personal, Family and Community Factors

Research focusing on persistence of African Americans in STEM and mathematics majors suggests the importance of parental and family support during the college years, and the significance of enriching early learning experiences which fostered interest in science and mathematics (Palmer et al., 2010; Strayhorn, 2015). Some students attribute their motivation and persistence in mathematics to a personal sense of responsibility

toward their families and communities as a role-model for younger generations (Ellington & Frederick, 2010).

Likewise the presence of local, community, or family struggles ranging from employment and familial responsibilities to the effects of traumatic events can pose barriers to persistence by impacting course attendance and preventing academic focus and subsequent success in STEM-related courses of study (Palmer et al., 2010). Inter-role conflict can be a concern for female nontraditional students, who might have to balance parenting or other familial care-giving roles with the demands of college attendance and other academic responsibilities (Markle, 2015).

Institutional Factors

For nontraditional students, institutional policies such as schedules or office hours that conflict with logistical needs have been cited as barriers to success or reasons for withdrawing from college (Markle, 2015). Research also indicates that the availability of flexible scheduling, online courses and child care seem to have positive effects on academic performance and retention (Brock, 2010; Drew et al., 2015; Markle, 2015).

Some 2- and 4-year public colleges in Florida have formed partnerships in response to the identified need for flexible scheduling and distance education, and as an effort to recruit and retain more minority students in STEM fields. The University of Florida offers a 2+2 degree program, which allows students to earn an associate's degree at a local community college and then transfer to a 4-year program to complete a bachelor's degree. More recently, a hybrid program was developed to provide students the option of enrolling in online, distance education opportunities at the 4-year college. The online program offers parallel courses with the same content and assessments, as well as

opportunities to participate in face-to-face lab sessions (Drew et al., 2015). Results from a three-year study suggest that the 2+2 hybrid program has increased overall STEM enrollment at the University of Florida without disrupting the existing on-campus programs, and survey results showed that distance education students appreciated the flexibility to maintain family and work responsibilities while enrolled in a degree program (Drew et al., 2015). The study compared three cohorts of students: traditional students, and two groups of 2+2 degree transfer students: on-campus and distance education. The three groups showed comparable outcomes as measured by grade point average and graduation rates (Drew et al., 2015).

These institutional factors and efforts are important and relevant to the present study, as the study site enrolls a substantial proportion of nontraditional students who might experience constraints with scheduling and other logistical considerations. Findings from this study might indicate similar institutional policies or services as factors or barriers to success in mathematics.

Financial Factors

Research shows that financial concerns can pose a barrier to persistence and success in undergraduate studies (Brock, 2010; Palmer et al., 2010), and that Black men can experience a greater degree of financial concern due to family obligations (Markle, 2015). However, financial assistance alone might not guarantee success in STEM and mathematics degree programs (Chang et al., 2016; Ellington & Frederick, 2010).

The National Science Foundation (NSF) funded scholarship programs designed to recruit and retain underrepresented minorities and first-generation students in the mathematics and physical sciences disciplines. A large, urban state college in the

western United States implemented one such NSF scholarship program between fall 2010 and spring 2015, based on an identified need to support minorities in their pursuit of STEM degrees (Chang et al., 2016). In addition to financial assistance, the program included community-building and faculty mentorship components. Before the NSF scholarship program was implemented at the college, the 6-year graduation rate for minority students pursuing STEM degrees ranged from 11% to 18%. By spring 2014, 50% of the scholarship students who graduated from the college with STEM degrees were underrepresented minorities, whereas a mere 22% of the STEM graduates overall at the college were underrepresented minorities. According to data from an informal program evaluation survey administered during the 2013-2014 academic year, 76% of respondents indicated that money was a major factor that helped with overall success in the major (Chang et al., 2016). Students also identified mentorship and sense of community as motivators for persistence in the degree program.

While Chang, et. al (2016) indicate that 9 of the 11 mathematics majors who participated in the NSF scholarship program were underrepresented minorities, they do not specify what proportion of those participants were Black. Even so, similar overlapping factors to persistence may be found to impact the students in the present study.

Retention of Blacks in College STEM and Mathematics

While much traditional research focuses on factors associated with persistence in higher education for STEM students, it is also important to examine the existing research on institutional and community efforts and their impacts on retention. Institutions and communities have implemented numerous interventions in order to positively influence

motivational factors such as sense of belonging, self-efficacy and academic preparation in order to increase retention and success (Tinto, 2017).

Programs and Partnerships

Higher education institutions throughout the United States have implemented personal, social and academic preparation programs or partnerships in order to address barriers and increase potential success for underrepresented students (Fowler & Boylan, 2010). These programs and partnerships exist in response to low performance and persistence in mathematics and STEM majors and intend to interact with the P-20 pipeline for minority students by changing the environment rather than fixing the student, and thus act as disruptions to the pipeline for Black students (Asera, 2001; Joseph et al., 2017; Maton et al., 2000). Nearly all are oriented toward recruitment and retention in postsecondary education (Slade, Eatmon, Staley, & Dixon, 2015), and some specifically aspire to recruit or retain students in STEM fields (Maton et al., 2000).

At the high school level, programs typically seek to foster college-going attitudes, skills and habits in order to increase academic and social preparation, and ultimate enrollment and success in postsecondary education (Contreras, 2011). High school programs such as Advancement via Individual Determination (AVID) are designed to promote academic identities and high levels of achievement through inquiry-based instruction and collaboration and to teach non-cognitive, college-going skills such as note-taking and time management (Conley, 2010; Mehan et al., 2008). The Minority Achievement Committee Program (MAC) in Shaker Heights, Ohio seeks to integrate collective group identity with academic identity via cooperative learning approaches, student-to-student mentorships, and creating a culture that highlights and celebrates

academic achievements in order to promote visibility, credibility, and recognition for African American students (McGovern, Davis, & Ogbu, 2008).

The Math Engineering Science Achievement (MESA) program is a statewide intervention, implemented in eight states, that works to promote mathematics and science education in the high school context. Evaluations of MESA suggest that participation in the program leads toward better performance in mathematics and science in school, increased overall academic achievement, and better access to a college-level curriculum (Contreras, 2011). In Washington State, MESA has exposed thousands of students to "rigorous math and science classes, summer bridge programs, after-school programs, mentors and role models from science-related fields, and college scholarship and preparation workshops" and has led to a higher number of minority students earning mathematics- and science-related degrees (Contreras, 2011, p. 511).

Summer bridge programs occur at college campuses during the summer between high school graduation and college enrollment. These programs include intensive academic and social sequences designed to integrate students into the community, and to prepare students for college-related academic, logistic and temporal challenges (Bir & Myrick, 2015). The University of North Carolina system has a longstanding network of summer bridge programs oriented specifically toward first generation students, academically underprepared students, and minority students. Their programs, which are informed partly by Tinto's (1975) theory of student departure, focus on building a sense of belonging by attending to students' affective needs and educational resiliency (Slade et al., 2015). Internal studies show that the 2-year retention rates of summer bridge

program alumni consistently surpass the general population of similar students who attend the same institutions (Slade et al., 2015).

During the 1970s a summer bridge program at Berkeley College prompted Treisman's (1992) ethnographic studies of the impact of campus climate on student performance, which ultimately led toward the creation of the Emerging Scholars Program (Asera, 2001). During his work with the summer bridge program Treisman (1992) recognized the motivation and academic potential of enrolled minority students and he later was disoriented when the same students failed introductory calculus courses (Asera, 2001). This observation supports later findings indicating that course structure and campus climate can impact outcomes for minority students (Alkhasawneh & Hargraves, 2014; Borum & Walker, 2012).

Traditional institutions offered lecture-based, fast-paced, hierarchically formatted mathematics courses that systematically weeded out students whose academic abilities were allegedly inferior (Moreno et al., 1999). Treisman (1992) advocated for courses that offered slower, more in-depth study of calculus so that students would understand the beauty and connectedness of mathematics rather than become confused and overwhelmed by what they perceived as a gigantic collection of formulas.

The Meyerhoff Scholars Program is another college-based program that was designed to make the campus environment more welcoming both academically and socially for minorities (Asera, 2001). Initially implemented at the University of Maryland in 1988 as an effort to recruit and retain Black males in STEM degree programs, the Meyerhoff Scholars Program exclusively accepted African American applicants until 1996 (Maton et al., 2000). The program incorporates a summer bridge program, financial support,

mentorship and internship opportunities, tutoring and peer support. Rooted in research on factors to success, the program actively focuses on academic and social integration, knowledge and skill development, support and motivation, and monitoring and advising (Maton et al., 2000). Meyerhoff students have achieved higher GPAs, graduated in STEM degree programs at higher rates, and were accepted to graduate degree programs at higher rates than both contemporary and historical comparison samples (Maton et al., 2000). Findings from interviews show that students attribute the Meyerhoff Scholar Program's success to the family-like environment that is centered on a collective positive academic identity, the availability of financial support, the involvement of program staff, and opportunities for research internships (Maton et al., 2000). Still in existence, the Meyerhoff Scholars Program has now served roughly 1,300 students and has been recognized by the NSF as a national model for supporting minority students in their pursuit of STEM degrees and careers (University of Maryland, n.d.).

Unfortunately, a number of programs and partnerships that potentially impact recruitment and retention for Black and African American STEM students are unsustainable for the long-term (Slade et al., 2015). When designing and implementing a program, it is paramount that the program be compatible with an institution's existing systems and structures in order for the program to be sustainable (Hsu et al., 2008). Grants and other temporary funding sources expire, curtailing the future flow of financial resources. Programs can lose momentum due to human capital turnover. For example, the Emerging Scholars Program relies on graduate students to act as mentors and tutors. As students graduate and move on, it is vital to maintain ongoing departmental support and enthusiasm for such programs so that upcoming students will be equally effective in

the same roles (Hsu et al., 2008). Hsu, et al. (2008) suggest that designating a space or room for a program can also provide a tone of prominence and permanence. These are important considerations for the present study, which explores factors associated with persistence and success at an under-resourced institution. Participants might reflect on the influence of certain programs or partnerships on their persistence within the mathematics degree program.

The Importance of Perspective and Perceptions

Traditional studies on persistence and success for Blacks and African Americans seek causes or reasons for a lack of retention among underrepresented minorities. Some of these studies implement and test remedies, interventions, or programs designed to increase participation and success in college and STEM fields (Bir & Myrick, 2015; Drew et al., 2015; Mehan et al., 2008). Such studies are undoubtedly important; they examine and evaluate ways to recruit more people of color into STEM majors and professions. However, traditional studies also run the possibility of focusing on social and contextual risk factors, thus recharacterizing the results in a stereotypical way or from a deficit perspective. This is harmful because it sustains the master narrative about educational outcomes and the notion of successful African American students as outliers, thereby maintaining the myth of intellectual inferiority (Harper, 2010; Howard, 2010; Martin, 2000; Perry, 2003). As I conducted the literature review for this study, I paid particular attention to how the research questions were framed, and to the ways in which findings were reported.

Studies that use anti-deficit achievement frameworks can uncover factors and influences on persistence and retention that might not otherwise be considered (Harper,

2010; Stinson, 2006). The primary purpose of an anti-deficit achievement framework is to "better understand how students of color persist and successfully navigate their ways to and through various junctures" of the education pipeline (Harper, 2010, p. 67). As such, it is also vitally important to listen to the perspectives of students who succeeded in their pursuits (Ladson-Billings, 1995; Martin, 2000).

Ellington and Frederick (2010) conducted an interview-based study of high achieving Black mathematics students from three universities on the east coast. The students predictably attributed their successes to faculty and peer groups, as well as non-cognitive factors including self-efficacy and positive attitudes. Five of the eight participants were scholarship recipients, and they indicated that financial support removed a substantial obstacle and thus allowed them to focus on success (Ellington & Frederick, 2010).

However, findings from Ellington and Frederick (2010) also suggested the importance of family and community influences on success. Some participants mentioned a personal sense of responsibility to act as positive role models for their home communities. In addition, several of the participants cited early family and schooling experiences where they received support and were offered opportunities, and they were encouraged or pushed to excel in mathematics (Ellington & Frederick, 2010). Similar studies that examined the perspectives of successful Black students at the middle school level (Berry, 2005), high school level (Stinson, 2008; Walker, 2006) and in higher education (Borum & Walker, 2012; Davis et al., 2004; Fries-Britt, 1998; Fries-Britt & Griffin, 2007; Harper, 2009; Moody, 2004) also indicate the importance of family and religious communities, among other influences.

Similar to the present study, these studies explore participants' personal reflections on their experiences and root findings in the voices of the participants. However, the aforementioned studies focused on high achievers as defined by GPA or participation in competitive scholarship programs. This study examines the voices of African American participants who successfully graduated, but perhaps not as high-achievers or scholarship recipients, or even as traditional students. Some of the participants might have entered college years after high school completion, and they might not have graduated within 6 years. Nevertheless, they experienced success and their perspectives must be heard. Their voices will fill an important gap in existing anti-deficit research, because they emerged from communities and experiences that are traditionally thought to sustain the cycle of underachievement.

Chapter 2 Summary

This chapter presented the historical context and literature review for this study, which explored the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution. The historical context for the study presented statistics regarding Blacks and African Americans in STEM professions, as well as data on college preparedness, enrollment, retention, and graduation among people of color compared with the general population. These data are situated with a P-20 education trajectory characterized by social and racial systems and structures that greatly impact opportunities and outcomes for Black students.

The literature review for the study synthesized research on factors associated with persistence in college STEM and mathematics degree programs. Social and cultural

factors, affective variables, academic and institutional factors emerged as both influences and barriers to success for African American students. Studies featuring the voices of high-achieving mathematics students indicated the importance of these factors, as well as family and community influences. Many of these studies focused on students who participated in institutional programs and partnerships designed to impact retention, or those who attended PWIs and yet persisted. Absent from these studies were the voices of some of the most marginalized students in the P-20 pipeline. The present study focuses on successful mathematics degree earners who attended an under-resourced PBI with an open admissions policy. This study will contribute toward a deeper understanding of how to afford success for similar students by exploring their reflections on experiences and how they came to be successful.

Chapter 3: Methodology

The purpose of this study was to explore the challenges and opportunities associated with building and sustaining a successful mathematics degree program committed to access and excellence at an under-resourced Predominantly Black Institution. I attempt to do this from the perspective of former students who graduated from the PBI with the mathematics degree. I share their reflections on their educational pasts, their college experiences, and the meaning they make of these lived experiences. To accomplish this I employed in-depth phenomenological interviewing as my research methodology (Seidman, 2013).

The primary research question guiding this study was: What are the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution? This study also addressed the following sub questions:

- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their life and schooling experiences?
- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their undergraduate experiences?
- What factors do Black women and men who have earned their degree in mathematics from an under-resourced PBI perceive to be associated with success in earning the mathematics degree?

In this chapter, I present the methodology for the study. The chapter begins with a rationale for the qualitative approach to research, and specifically for the in-depth, phenomenological interview-based research design. I present the research methods, setting, context and framework for analysis. Participants and sampling methods are discussed, as well as data sources, data collection methods, and data analysis methods. The chapter concludes with issues of trustworthiness associated with the study.

Rationale for the Qualitative Research Approach

For this interview-based study, I employed a qualitative inquiry approach. Qualitative inquiry is extremely important to the realm of education. It seeks not only to understand the world, but also to improve it (Smith & Hodkinson, 2005). While quantitative methods seek to systematically describe relationships, determine causes, or to predict possible outcomes, qualitative methods seek to deepen our understanding of people's perceptions, or how people interpret their experiences (Merriam & Tisdell, 2016). Qualitative research is an approach as opposed to a set of techniques. This type of naturalistic inquiry requires the researcher to give the reader a sense of having been present, and this can only be done by effectively giving a voice to the researched (Lincoln, 1995). I believe that the voices of the participants in this type of research yield a rich description that honors the complexity of their experiences and humanity. I do not believe we can truly understand educational issues by quantifying scholastic results. Where are the people in these numbers? When we venture beyond and beneath statistics and educational outcomes, there is much to be discovered within the human dimension of the Black mathematics experience.

Naturalistic inquiry meets humans where they are engaged in their worlds. It allows the marginalized to be empowered; it gives voice to the silenced (Creswell, 2013). The research does not occur in a laboratory setting and does not seek to manipulate or control what is being studied (Merriam & Tisdell, 2016). Interviews are a widely accepted technique for qualitative data collection (Merriam & Tisdell, 2016; Plano Clark & Creswell, 2010), and the primary purpose for one-on-one interviews is to access a person's perspective, or to "find out what is in and on someone's mind" (Patton, 1990, p. 278). In order to understand how Black mathematics degree earners interpret their life experiences, it makes sense to directly ask them. Interviewing is the most fitting way to give voice to the many layers and textures of the college mathematics experience from the perspective of successful African American students.

In-depth phenomenological interviewing acknowledges human complexity by placing the interviewee at the core of its mission (Seidman, 2013). This methodology, in and of itself, indicates that people have an important story to tell, and gives deliberate attention to the participants' lived experience (Seidman, 2013). The meaning that participants make of their experiences is central to the researcher's understanding because "at the heart of what it means to be human is the ability of people to symbolize their experience through language" (Seidman, 2013, p. 8). This has a benefit over surveys and other empirical research methods where sentences can appear stark and impersonal. By reconstructing the human experience, in-depth interviewing from a phenomenological perspective essentially places a heartbeat beneath the words.

Interview-Based Research

A phenomenologically based interview was appropriate for this study because it emphasizes the participants' reconstruction of their experiences, and the meaning they make from those experiences. As I employed the in-depth phenomenological interviewing methodology, I relied on the Seidman (2013) three-part phenomenological model, consisting of three separate in-depth interviews for each participant. In phenomenologically based interviews, "interviewers use primarily, but not exclusively, open-ended questions" (Seidman, 2013, p. 14). Each interview had a unique topic, purpose, and focus; the overall goal of phenomenological interviewing is to elicit stories, testimonies and reflections about each participant's lived experiences (Seidman, 2013).

Seidman (2013) makes several suggestions for the interviewing process. First, the three interviews be conducted within a few days of one another with one interview per day for each participant in order to prevent response fatigue. Second, the researcher conclude all three interviews within a week so that participants will easily recall their testimonies from prior interviews. Third, when interviewing multiple participants within the same time period, the interviewer space out the interviews between participants to allow time for the interviewer to compile notes and reflections between participants. These notes and reflections are used to inform clarifying questions and probes for reflection in subsequent interviews (Seidman, 2013).

While this study employed in-depth phenomenological interviewing methodology, it was not a phenomenological study. In phenomenological studies, the researcher seeks to provide a comprehensive description of the central underlying meaning of the participants' experiences (Creswell, 2013). The phenomenological researcher assumes

that there is an essential, invariant structure to a particular experience. As the researcher for this study, I believed that the unique perceptions and experiences of these graduates were valuable and I wished to explore them separately, thoroughly, and deeply. Although I recognized that there might be some commonalities among these graduates' experiences and beliefs, this study sought to tell each of their stories without a need to extract a particular unifying essence. Hence, a phenomenological approach was not appropriate for this study. Instead, I chose to employ an interpretive case study approach.

Case Study Research

A case study approach was selected for this study because it is used to organize and report the actions, perceptions, and beliefs of an individual or group under specific conditions. Case studies are characterized as particularistic, descriptive, and heuristic (Merriam, 1998). A case study is a *particularistic* exploration of a "bounded system" or case (or multiple cases) over time through detailed, in-depth data collection (Creswell, 2013). The system is bounded in terms of time in place, and the case studied could be a program, event, activity, or individuals. Typically the case is selected because it is an example of some phenomenon of interest (Creswell, 2013). For this study, each participant was bounded by the experience of having attained the mathematics degree from CPC, and each participant was considered an individual case. As such, each participant's personal, academic, and social experiences and perceptions were explored as an individual case. The *descriptive* nature of a case study suggests a portrayal of the phenomenon being studied by illustrating the complexities of a situation through quotations and thick, rich description (Merriam, 1998). The goal of this study was to not only describe the participants' experiences, but to understand the nature, meaning and

relationships among these experiences. The *heuristic* nature of case study speaks to the uniqueness of this approach. The knowledge gained from case study research is (1) concrete in that it resonates with personal experience, (2) situated in a particular context, (3) developed, in part, by reader interpretation, and (4) based on reference populations that the reader brings to mind rather than an extensive, generalizable population (Merriam, 1998). A case study approach was appropriate for this study because the particularistic, descriptive, and heuristic nature of case study research aligned with the purposes and goals of this study.

Case study research can also be characterized by its intent. While *descriptive* case studies present a detailed account of a phenomenon, *interpretive* case studies use descriptive data to develop conceptual categories or to illustrate, support, or challenge theoretical assumptions held prior to data gathering. Merriam (1998) asserts:

> The level of abstraction and conceptualization in interpretive case studies may range from suggesting relationships among variables to constructing theory. The model of analysis is inductive. Because of the greater amount of analysis in interpretive case studies, some sources label these case studies analytical. Analytic case studies are differentiated from straightforward descriptive studies by their complexity, depth, and theoretical orientation (p. 38).

Given the purposes and research questions guiding this study, I believed that an interpretive case study approach enabled me to better understand the participants individually in order to tell their stories and collectively in order to explore their perceptions associated with persistence and success.

Research Setting, Context, and Framework for Analysis

Because this study elicited the stories and experiences of four participants who graduated with a mathematics degree from a specific under-resourced PBI, I believe it is

important to acknowledge the setting and contexts from which these graduates emerged. However, it is equally important to reject the impulse to focus solely on these contexts by fueling harmful accounts from an outsider's perspective, and in effect preserving the master narrative. Master narratives, or majoritarian stories, are dominant accounts that are often accepted as universal truths about particular groups, and such scripts implicitly convey assumptions about these groups according to negative stereotypes (Solórzano & Yosso, 2002). This study used an anti-deficit achievement framework to explore the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution.

Setting and Context

The study site was the Mathematics Department at CPC, an accredited, regional, four-year, Predominantly Black Institution located in the eastern United States. CPC is a nonselective, open-enrollment college that offers a range of associate and bacalaureate degree programs rooted in the liberal arts including business, STEM, education, and nursing. The college is situated in a large, urban area that draws a majority of its students from the local geographic region. The city is densely populated and ethnically diverse. Amidst this vibrant celebration of diverse cultures and communities, the region experiences the concentrated effects of stressors associated with poverty: unemployment, low incomes, housing instability, low educational attainment, immigrants, disconnected youth, and other factors. In some local neighborhoods, obesity, limited prenatal care, asthma, domestic violence, homicide rates, and incarceration rates are among the highest in the city (Anonymous, 2014).

During the 2015-2016 academic year CPC enrolled about 6,800 part-time and full-time students, 77.5% of whom were Black or African American. In addition, 13.1% of enrolled students were Hispanic, 2.5% were Asian American, 1.8% were White, and 3.3% were non-residents of the United States. During the 2014-2015 academic year, 81% of full-time CPC students were awarded Pell Grants, which is an indicator of financial need. More than 90% of students at CPC typically receive some form of financial assistance (Anonymous, 2017).

For the cohort of students who enrolled as freshmen in 2007, the 4-year graduation rate was 5%, the 6-year graduation rate was 15%, and the 8-year graduation rate was 19%. These percentages are fairly representative of historical graduation rates for the college. The retention rate for first-time, full-time freshmen at CPC, meaning the percent of students who return for their sophomore year, is between 63% and 66%. The four-year retention rate is between 19% and 26% (Anonymous, 2017).

At CPC, a majority of students enter underprepared for college-level coursework according to regional placement tests that students are required to take prior to enrollment. Based on placement test results, 50.7% of the fall 2007 cohort needed the basic skills course in writing, 63.6% needed the basic skills course in math and 29.6% needed the basic skills course in reading (Anonymous, 2014). These results evidence genuine gaps in understanding of the fundamental concepts of arithmetic, algebra, and trigonometry that are necessary for not only success in college-level mathematics courses but also meaningful participation in courses leading toward STEM undergraduate degrees. That same year, 45% of students did not return the following semester and roughly 50% of freshmen did not return for their second year.

The basic skills course in mathematics is one of two developmental, non-credit bearing courses offered at CPC. In total, CPC offers six courses below Calculus I, the traditional starting point for an undergraduate major in mathematics or the sciences. Approximately 80% of incoming first-time freshmen at CPC begin their studies in developmental courses. Of the entering freshmen that place in non-developmental courses, 3-5% place in Pre-Calculus and only approximately 1% begin their studies in Calculus I. Accordingly, a typical CPC student pursuing a STEM degree takes two years to satisfy all requirements before entering Calculus I, but only *if* the student effectively completes the courses. The pass rate for most of the mathematics courses below Calculus was 50% or less according to an internal study in 2005, meaning the majority of students failed or withdrew prior to course completion. To provide further context, around 1,400 students were enrolled in math courses at CPC in 2007-2008. Of those students, only 181 (12.6%) were taking courses in Calculus I or higher (Anonymous, 2014).

The aforementioned enrollment, retention, attrition, graduation, remediation, and pass rates are important because they demonstrate the structural challenges faced by CPC and other PBIs. However, they are merely statistics. There are so many human stories beneath these numbers. In the following sections I will discuss the participants for this study, but first I provide the final and most important layer of context about the research setting.

The Mathematics Department, which seeks to provide an intellectually rigorous and engaging curriculum that promotes critical thinking and emphasizes problem solving, is housed within one of four schools at CPC. The school enrolls roughly 40% of CPC students, and it offers degrees in mathematics and several science, technology, and health

sciences disciplines. During the 2015-2016 academic year, 46 students were enrolled in the mathematics major at CPC. The Mathematics Department was established in 2000, and by 2015 awarded 41 bacalaureate degrees in mathematics. Thirty-two of those degrees were awarded to Black or African American students.

Given the daunting structural challenges confronted by CPC and other PBIs and Minority Serving Institutions, the relative success of the Mathematics Department at CPC is remarkable. This study shifts the emphasis away from the quantifiable outcomes, and in doing so underscores the success stories that deserve to be told and must be heard. The expertise gleaned from these stories and experiences will provide context from which to explore the primary research question for this study.

Framework for Research and Analysis

As I framed the research questions and interview questions, I intentionally precluded negative contexts and outcomes. I sought to understand the participants' experiences, perspectives, and beliefs about persistence and success as they pursued the mathematics degree. By using an anti-deficit achievement framework, this study ventures beyond and beneath the outcomes a traditional study might seek to fix. The primary purpose of an anti-deficit achievement framework is to "better understand how students of color persist and successfully navigate their ways to and through various junctures" of the education pipeline (Harper, 2010, p. 67). The most important components of an anti-deficit achievement framework lie in the ways the research questions and findings are conceptualized and contextualized. As I analyzed and represented data from this study, I also incorporated components of Critical Race Theory (CRT), which fit seamlessly with the anti-deficit achievement framework (Harper, 2010). Social theories can enable

individuals to place stories and experiences within larger sociopolitical contexts, and this study highlighted the voices, perspectives, and experiences of four successful graduates from a program that an outsider might assume produces only failure.

Critical Race Theory (CRT) is a theoretical framework through which to examine and challenge the ways race and racism implicitly and explicitly impact social structures, practices and discourses (Yosso, 2002). CRT can be used to deconstruct the meaning of *educational achievement*, and to provide the theoretical justification for oppositional *counterstories* that challenge educational assumptions from an outsider's perspective (Parker et al., 1999; Yosso, 2002). Thus, CRT provides a way to understand how seemingly race-neutral structures in K-12 and post-secondary education such as knowledge, merit, and objectivity actually help form and maintain the boundaries of white supremacy and racism (Joseph et al., 2017; Yosso, 2002).

CRT has several components or tenets. For this study, and through the anti-deficit achievement framework lens, I incorporated counterstories, sometimes referred to as counternarratives. Solórzano and Yosso (2002) introduce counterstorytelling as an analytical framework for education research. They define this as a method of telling the stories of people who are often overlooked in the literature, and as a means by which to examine, critique, and counter the master narratives composed about people of color. Solórzano and Yosso (2002) note that research and theoretical models that seek to explain the achievement gap often support majoritarian viewpoints through deficit frameworks of people of color. As such, a counternarrative exposes deficit-based research that "distorts and silences the experiences of people of color" (Solórzano & Yosso, 2002, p. 29).

The participants from this study are the experts of their own experiences, and their stories and perspectives permitted me to uncover factors and influences on persistence and retention that might not otherwise be considered (Harper, 2010; Stinson, 2006). Solórzano and Yosso (2002) identify three types of counternarratives: personal stories, other people's stories, and composite stories. The second was selected for use in this study, since this is not my personal story. These are the participants' stories. I heavily integrated direct quotes and first-person voice so the reader will hear what they had to say. Solórzano and Yosso (2002) remind us poignantly, "in documenting the voices of people of color, our work tells their stories" (p. 36).

Participants

The participants for this study were four graduates of an undergraduate degree program in mathematics at an under-resourced regional college in the eastern United States. The interview-based study was designed to elicit their stories and reflections, with a focus on their perceptions of factors associated with persistence and personal success as they navigated the degree program, the courses, and other aspects of the college experience.

Research Sample and Data Sources

Research Sample

In qualitative studies and particularly in case studies, the researcher intentionally selects or recruits participants who have experienced the central phenomenon being explored. This is referred to as purposeful sampling (Plano Clark & Creswell, 2010). The sampling method for this study was purposeful criterion sampling, meaning I selected the study participants based on a set of criteria (Creswell, 2013). The use of

criterion sampling provides quality assurance as the researcher seeks to develop an in-depth exploration of a central phenomenon (Creswell, 2013; Plano Clark & Creswell, 2010). For this study, the central phenomenon was successful completion of the mathematics degree program at an under-resourced PBI. Participants were recruited from a sample set of thirty-two Black and African American people who graduated from the mathematics degree program at CPC from 2005-2015, and the sample was initially limited to 8 participants. One participant later withdrew from the study, and during the analysis phase I reduced the sample to participants who grew up in the American school system.

In March 2015, an email was sent to all graduates who met the criteria for participation and whose email addresses were on file in the alumni database at CPC. Dr. Phillips authored and sent this email, which introduced the purpose for the study and sought volunteers to participate in face-to-face interviews during the summer of 2015. The text of this initial email can be found in Appendix A. Dr. Phillips informed respondents that I, his graduate research assistant, would travel to CPC and contact participants in order to schedule and conduct interviews.

Data Sources

Data comprised face-to-face, one-on-one, in-depth phenomenological interviews. The interviews focused on a variety of topics including life history, early educational experiences, the college experience, and the meaning participants make of those experiences. *Table 2* outlines the three-part interview structure, including the topics, purpose, and focus of each interview.

Table 2: Interview Structure

	Interview 1	Interview 2	Interview 3
Topics	Personal background, family experiences, early schooling experiences, childhood influences, description of how participant came to be a student at CPC	Description of the college experience, the mathematics experience, relationships with faculty and peers at CPC, and life after graduation	Reflection on life experiences and college experiences, significance of those experiences, and the connections among those experiences; perceptions about recruitment, retention, and graduation
Purpose	To learn about participants' personal and educational history, to allow participants to reconstruct their life experiences	To allow participants to reconstruct their college and mathematics experiences, to learn their perceptions of personal successes and obstacles	To explore how participants interpret meaning from their experiences, to learn their perceptions and beliefs about successful college completion
Focus	Participant stories, research sub-questions #1 and #2	Participant stories, research sub-questions #2 and #3	Clarify questions from previous interviews, research sub-questions #1, #2, and #3

Prior to the interview process, I developed a semi-structured interview protocol based on Seidman's (2013) three-part phenomenological model (See Appendix B). A semi-structured interview protocol is a flexibly worded form designed by the researcher that contains the questions to be asked or issues to be explored, and it often contains space for the interviewer to take notes of participant responses (Plano Clark & Creswell, 2010). Rather than a structured interview, which adheres to a rigid set of questions to be asked in a predetermined order, a semi-structured interview allows the researcher to respond in-the-moment to participant testimony, ideas, or topics (Merriam & Tisdell, 2016). The

protocol, which is designed to be used during the interview, might also contain instructions for the interview process (Plano Clark & Creswell, 2010).

The semi-structured interview protocols for this study included a standard script that was read to participants at the beginning of each interview, the list of questions to be asked, and possible probes underneath. Space was left after each question to allow for note-taking during the actual interview. The second and third protocols began with space to summarize the prior interview and to probe for further details on experiences or stories as needed for the purposes of the study. Examples included questions such as, "During our last meeting you spoke about ____, ____, and ____. Can you tell me more about ____?" This open-ended beginning enabled me to personalize subsequent interviews in order to re-establish rapport and to invite each interviewee to clarify or expand upon what was already said (Seidman, 2013).

All interviews with participants were conducted and recorded at the research site. Each interview was transcribed in its entirety, and the transcriptions were the primary source of data for the study. Interview recordings and transcriptions were kept confidential and stored in a password-protected file on the researcher's computer. Back-up recordings remained stored in a password-protected external flash drive.

Demographic data were not explicitly collected for this study. However, some participants indicated their ethnic background, national origin, or age during the interview process. In some cases, these identifiers were omitted from interview transcriptions in order to protect participant identity. Names were changed or removed from transcriptions, and stories that referenced geographically specific events or locations were omitted from the study.

Data Collection Methods

For the data collection process I traveled to the research site in July 2015. I scheduled and conducted interviews on a rolling basis over the course of three weeks. Throughout my stay I remained flexible to the practices and policies within the School of Science and Technology, and during the interviews I sought to provide a comfortable and open rapport with each participant.

Once I arrived at the research location, I immediately met with Dr. Phillips in order to orient myself to the neighborhood and to discuss details for the interview process. Two days later, Professor F. welcomed me to CPC and gave me a tour of the Mathematics Department. Dr. Phillips provided the list of potential participants and their contact information so I could begin to schedule interviews. Dr. Phillips had advised me that due to the nature of the community, it made more sense to schedule the interviews after my arrival. I later learned that many of the participants were excited about the *Telling Our Stories* study because they explicitly told me so. But, they perhaps felt more comfortable participating once they met me in person.

Many of the participants remained closely connected with the college even after graduation, and so I was able to schedule most of the interviews in person. Dr. Phillips had recently accepted a position as head of the mathematics department, and my visit coincided with his first week on campus. For this reason, many of the students stopped by unannounced to welcome Dr. Phillips back to the community. Throughout my three-week stay at the research location, Dr. Phillips introduced me to graduates as they visited. Often during those conversations the participants would schedule their interview for later

the same day or the following day. The participants and I scheduled subsequent appointments at the conclusion of each interview.

Interviews

Each participant was interviewed three times in July 2015 in the Science and Technology building at CPC. Ideally, a researcher would set up the interview space ahead of time in order to ensure privacy and physical comfort, and to test sound quality to confirm a clear audio recording (Creswell, 2013), but this was not possible due to the policies and systems enforced at the research site. The Science and Technology building was highly secure; all doors remained locked, and few people on campus had access to the keys. For this reason I consulted with Dr. Phillips and the then dean of the School of Science and Technology each morning to secure a room for the day. I conducted interviews in whatever private space was available: typically an empty conference room, Dr. Phillips's office, or Professor F.'s office. Each location had a different physical set-up and I was not always able to enter the room prior to conducting the interview. This presented a challenge for me because I prefer to feel prepared. However, this is the nature of qualitative research (Glesne, 2011) and so instead the interviewee and I set up the room together. I invited the participant to select a comfortable seat and then I situated the interview materials and myself. My interview materials included a folder containing informed consent forms, the interview protocol, a pen, a recording device, and a back-up recording device. I also ensured that each participant had water and felt otherwise comfortable before beginning the interview.

I began each interview with a brief conversation intended to establish rapport with the interviewee. A universal challenge to the interview process is the consequences of the

researchers' actions and subjectivities (Roulston, deMarrais, & Lewis, 2003). As the interviewer for this study, I remained acutely aware of my positionality as a White woman and as an outsider in a seemingly close-knit mathematics community comprised predominantly of African American and Black students and faculty (Lincoln, 1995). Thus, it was important to build rapport with each participant, which I did initially by sharing anecdotes about my professional relationship with Dr. Phillips, who is an esteemed and respected presence at the research site. Dr. Phillips had introduced me to the participants via email several months prior, and so upon meeting each participant in person I discussed my working relationship with him at my current university. I told each participant I was excited to finally visit the college and community we had spoken so much about. Often this conversation happened on the way to the interview space, or as we situated the room for a comfortable interview experience.

Prior to conducting the first interview for each participant, I obtained informed consent (Seidman, 2013) by sharing the consent form, which is found in Appendix C. I read the form aloud to each participant to ensure that each participant understood the purpose of the study, the nature of the three-part interview process, and that their participation was entirely voluntary. I invited questions and reiterated that they may ask questions at any time during or after the interview process. Once they signed the informed consent, I advised participants that they could pause the recording at any time and showed them how to do so on the recording device. After each participant indicated that he or she was ready to begin, I initiated the audio recording and the interview.

The phrasing and negotiation of questions poses another significant challenge to the interviewing process (Roulston et al., 2003; Seidman, 2013). The semi-structured

interview protocols, which are located in Appendix B, included open-ended questions that were crafted to elicit meaningful and truthful responses (Seidman, 2013). These questions were designed to provoke recollections of significant experiences, people, and circumstances related to life history and the college experience. During each interview I followed the semi-structured protocol, and made handwritten notes directly on the protocol for possible probes as the participant spoke. Probes and follow-up questions are recommended in qualitative studies in order to gather rich, detailed information about the phenomenon being researched (Patton, 1990), and I used probes specifically to prompt deeper reconstructions of experiences, encounters, or pivotal moments. As I took notes, I laid the protocol flat on the table where the interviewee could see it, in order to ensure transparency and to prevent discomfort. I allowed participants to finish responding before probing for further detail.

I was careful to complete each interview within the one-hour time frame we allotted in order to respect each participant's time commitment (Seidman, 2013). I kept track of time and informed the participant if we were approaching the one-hour mark. During the interview I sought to listen actively without showing privilege or bias toward any specific answer or topic. Instead I tried to allow the interviewee to speak without verbal interruptions or affirmations in order to elicit the most authentic stories and testimonies (Seidman, 2013).

At the end of the first and second interview, I scheduled the following interview with each participant. Subsequent interviews were typically scheduled within two days. I discouraged participants from scheduling subsequent interviews on the same day in order to avoid response fatigue. Before each subsequent interview, I read my notes from the

prior interview in order to write a summary of what the interviewee said. I sought to keep the summaries objective, and to use the same vocabulary the participant used. I began each subsequent interview by reading the script and then the personalized summary. This allowed participants to recall details from the prior interview and to clarify or expand on certain points.

Finally, after each interview, I confirmed the audio recording and uploaded it to a secure file on my computer and to a separate, secure file on an external flash drive. Interview recordings have remained securely stored on my computer in a password-protected folder. As the initial principal investigator, Dr. Phillips has back-up recordings of all interviews in his possession, and these recordings are located in a password-protected flash drive.

Interview Fieldwork Notebook

In order to provide further context and texture for analysis, I maintained an Interview Fieldwork Notebook during my time at the research site (Glesne, 2011). The notebook contained the final interview schedule with locations and five personal memos. The memoranda describe the campus and community environment, the interviewing experience, hunches and observations, some logistical considerations, and the initial transcription reflections. Excerpts from my Interview Fieldwork Notebook are located in Appendix F.

Data Analysis

Creswell (2013) and Lichtman (2006) agree that there is no standard, universal or linear approach to qualitative data analysis, because qualitative data collection often produces a vast and amorphous data set. However, they suggest that data analysis begin

with a systematic and structured sequence with the understanding that the process will change as themes and ideas emerge (Creswell, 2013; Lichtman, 2006).

In order to analyze the data for this study, which explored the challenges and opportunities associated with building and sustaining a successful mathematics degree program an under-resourced PBI, I adhered primarily to Creswell's (2013) three steps for qualitative data analysis. These steps include (1) preparing and organizing the data, (2) reducing the interview data to themes through coding and condensing, and (3) representing the data in a discussion of the findings. I also used within- and cross-case analysis strategies for theme identification (Ayres, Kavanaugh, & Knafl, 2003).

Preparing and Organizing the Data

For this study, the raw data initially took the form of transcriptions derived from roughly 30 hours of interviews with 8 participants. The transcriptions included all researcher questions, comments, and probes verbatim. I also transcribed participant responses verbatim, except I removed vocal hesitations and repetitions for clarity. The transcriptions included time stamps while laughter, pauses, and other contextual responses were placed in brackets. I triangulated these with notes taken during the interview process for accuracy. In order to preserve confidentiality, I changed or omitted names, locations, and other identifying information in the transcriptions. In addition, I used pseudonyms for community members mentioned by more than one participant.

One participant withdrew from the study when I sent the transcripts for member checking, and three participants were omitted later during the data analysis phase. Some excerpts from the three removed participants' interview transcripts are located in Appendix G.

Coding and Condensing

The second step for qualitative data analysis is reducing the interview data to themes through coding and condensing (Creswell, 2013). This was an iterative and cyclical process, and I sometimes worked through parts of the process simultaneously as I read and reread, organized and reorganized, categorized and recategorized. To organize the interview transcription data into codes, I used *nVivo*, a software program designed to facilitate the organization and categorization of large, qualitative data sets. Once I began coding in *nVivo*, I maintained two separate research journals, as Lichtman (2006) suggests, to keep track of my process and thoughts throughout the data analysis process. I kept a digital document entitled Data Analysis Notebook, and a handwritten notebook where I jotted concepts and notes as they occurred to me. Drawing from the practices outlined by Creswell (2013) and Stake (1995), I employed within- and across-case analysis to reduce the coded data into families of themes, which I then organized according to the research sub-questions.

Near the end of the coding process, but before I reduced the data to final themes, I returned to the raw data and reread each set of interviews to reorient myself with each participant's testimony. This is because coding decontextualizes the data by separating it into units of meaning, and an important purpose of this study was to document the participants' experiences (Ayres et al., 2003; Stake, 1995). To do this, I identified significant statements within the transcripts and categorized these as *memorable quotes* (Seidman, 2013). I used these to help inform the participant's counternarratives (Solórzano & Yosso, 2002), but I went a step further. Seidman (2013) suggests that a researcher not just let the thematic excerpts speak for themselves. Beyond that, the

researcher must engage more deeply toward the meaning the participants make of their experiences and thus undergo a process of *intuiting*. This process, Seidman (2103) argues, enables the researcher to reconstruct a more appropriate and accurate interpretation.

Discussion of Findings

The third step of qualitative data analysis is representing the data in a discussion of the findings (Creswell, 2013). A discussion of findings gives form to mountains of carefully organized and analyzed qualitative data and provides space for the researcher to interpret and transform the data into rich, textural descriptions (Glesne, 2011). Findings from this study were presented in two parts: stories and themes. Stories took the form of *counternarratives*, which were presented in Chapter 4. Themes from this study were presented in Chapter 5.

Creswell (2013) also suggests that a researcher, within the discussion of findings, make deeper sense of the data. This aligns with the final step of analysis in an interpretive case study, in which the researcher constructs a richer, inductive level of meaning from the findings (Merriam, 1998). In doing so, I abstracted the themes and created a visual representation of the participants' overall experience with successful attainment of the mathematics degree.

I then connected the findings and themes back to the primary research question, which anchored this study. The majority of the findings from this study were reported as persistence factors from the perspective of the successful student, and they addressed the research sub-questions, which captured the nature of the participants' experiences. However, the primary purpose of this study was to explore the challenges and

opportunities associated with building and sustaining a successful mathematics degree program committed to access and excellence at an under-resourced Predominantly Black Institution.

Credibility

Credibility is the qualitative term typically used for internal validity. Internal validity is a construct that normally grapples with the question of how well the research findings match reality (Merriam & Tisdell, 2016). However, the naturalistic paradigm assumes that reality is actually a compilation of multiple constructed realities, that "reality is holistic, multi-dimensional, and ever-changing; it is not a single, fixed, objective phenomenon waiting to be discovered, observed, and measured as in quantitative research" (Merriam & Tisdell, 2016, p. 242). Even though there is no one correct interpretation of reality, the explanation of the data should be credible. In other words, the research participants should be accurately identified and described throughout the study. In order to ensure that I accurately and safely represent each participant's stories and testimonies, I employed the following strategies.

Member-checking: Member checks were conducted twice during this study. First, I returned the transcribed interviews to all participants so they could review their transcriptions for accuracy and clarity. I later sent each participant his or her counternarrative and invited the opportunity for approval, feedback, or revisions before I proceeded with final steps of data analysis for the study. To ensure that they did not prohibit my moving forward with the research, participants were given a 2-week time limit to respond to each member check request (see Appendix E). Scholars agree that member checks are vital to establishing credibility (Janesick, 2003; Merriam & Tisdell,

2016), therefore they were used not only to ensure the credibility of this study's findings, but also to enhance the integrity and preserve the authenticity of participants' voices (Palmer et al., 2010).

Negative case analysis: A purposeful search for data takes time and full engagement during the data collection process, and the most credible studies interview to the point of saturation (Plano Clark & Creswell, 2010), or until "you begin to see and hear the same things over and over again" (Merriam & Tisdell, 2016, pp. 247–248). This is time well-spent because not only does it allow for rich and detailed analysis, but also a search for alternative explanations within the data. Once I finished with the initial data collection and subsequent analysis, I employed *negative case analysis*, which means I further refined the analysis via a cross-check with individual interviews and journal notes to ensure consistency. In doing so, I made sure all elements from the raw interview transcript data supported the themes and conclusions, without any contradictions. The intentional search for disconfirming data falls within the realm of adequate time spent with data collection and analysis and is a way to further enhance credibility (Merriam & Tisdell, 2016).

Reflexivity: The act of engaging in *reflexivity*, or an undertaking of self-aware meta-analysis, recognizes that qualitative research inherently is a product of the researcher, the researched, and the relationship between the two (Finlay, 2002). Meaning is negotiated within that particular social context, and so it is vital for the researcher to navigate a path through this relationship. Reflexivity can also be understood as a "confessional account of methodology" by examining a researcher's personal reactions (Finlay, 2002, p. 224) in

order to help a reader "better understand how the individual researcher might have arrived at the particular interpretation of the data" (Merriam & Tisdell, 2016, p. 249).

While reflexivity is sometimes contested in the realm of naturalistic inquiry because it might focus too much on the researcher at the expense of the participants (Finlay, 2002; Glesne, 2011), I felt it was important for this particular study. As a White woman and a community outsider, I did not share the participants' social, racial, or mathematical background. Throughout the research process I paid careful attention to my positionality, my underlying assumptions, and my personal motivations (Glesne, 2011). This manifested itself through intersubjective reflection as I negotiated the research relationship, specifically in the way I conducted myself at the research site and in the ways I intentionally worked to build and maintain a personal rapport with each participant throughout the interview process. I also maintained an introspective process as I conducted background research, formulated interview questions, and interpreted and synthesized findings from the study.

Clarification of the researcher's assumptions and biases is yet another way to ensure that the findings are credible (Merriam & Tisdell, 2016). Every researcher brings her background, past experiences, biases, and motivations to the study. The act of acknowledging and being attuned to a researcher's assumptions helps counter the tendency to incorporate those underlying biases and values into the research project (Glesne, 2011). I clarified my background, biases, and assumptions by articulating them at the onset of this study, and I conveyed my motivations through the ways I conducted and framed the contextual research, methodology, and findings for this study.

Transferability

Transferability is the qualitative term typically used for external validity. Transferability is concerned with the extent to which the findings from one study can be applied to other contexts, settings, populations, or situations (Merriam & Tisdell, 2016). The notion of transferability is distinct from generalizability because of the situated nature of qualitative research. What we learn from a particular situation can be transferred to a similar situation because "every study, every case, every situation is theoretically an example of something else" (Merriam & Tisdell, 2016). A researcher must enable readers to compare the fit of the study with other situations. To establish and enhance transferability, I employed the following strategies.

Rich, thick descriptions: I presented a highly descriptive and detailed depiction of the setting and findings of the study, using plentiful quotes from participant interviews to support findings and evidence. This is referred to as *rich, thick descriptions*, and it contextualizes a study such that a reader is able to determine how closely his or her situation aligns with the research situation (Merriam & Tisdell, 2016).

Careful sample selection: Purposeful participant selection with regard to variation, diversity, and/or typicality allows for a greater range of transferability (Merriam & Tisdell, 2016). Using more than one case to study the same phenomenon allows a reader to note the transferability of findings across cases. In addition, I interviewed a modal sample of Black mathematics degree earners who attended an under-resourced PBI. Both of these tactics strengthen the transferability of a study's findings.

Chapter 3 Summary

This chapter presented the methodology for the study, which explored the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced PBI through the use of in-depth phenomenological interviews and an interpretive case study approach. It began with a rationale for the research approach and described the research setting and context, and the methods for sampling and data collection. It outlined the approach to data analysis and provided a theoretical framework for the analysis and discussion of findings. The chapter concluded with the study's credibility and transferability.

Chapter 4: Presentation of Findings

The first purpose of this study was to explore the challenges and opportunities associated with building and sustaining a successful mathematics degree program committed to access and excellence at an under-resourced Predominantly Black Institution. The primary research question guiding the study was: What are the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution?

An equally important purpose of this study was to document the experiences of graduates from an undergraduate degree program in mathematics at an under-resourced PBI. Additional research questions included:

- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their life and schooling experiences?
- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their undergraduate experiences?
- What factors do Black women and men who have earned their degree in mathematics from an under-resourced PBI perceive to be associated with success in earning the mathematics degree?

To accomplish this I conducted a three-part series of interviews with four participants who graduated from the same PBI with a degree in mathematics. The phenomenological interviews provided participants a rich opportunity to share their experiences on a

multitude of topics related to early childhood and schooling, the college experience, perceptions about college preparation, persistence, and success (Seidman, 2013).

Chapter Four presents findings from these interviews in the form of counternarratives. These four graduates are the experts of their own experiential realities; therefore their voices will materialize as they explain their personal journeys, insights, and the meaning they make of those experiences (Harper, 2010; Solórzano & Yosso, 2002).

The pseudonyms Sal, Alexis, and Trevor, and Evan were assigned to participants, and all other identifying information was removed or changed to maintain anonymity. Participants were given the option to specify a preferred pseudonym. For those who declined, I took care to select pseudonyms that suited each participant's demeanor with the understanding that nothing fits quite as well as a person's given or chosen name.

Telling Their Stories

The stories presented here are the result of interviews that took place in July 2015. The four participants grew up in the United States and graduated from Clementa Pinckney College (CPC) with the mathematics degree, but these stories are so much more than a compilation of the participants' answers to the interview questions. The participants reconstructed experiences and shared reflections about family and community, lessons and influences, successes and struggles. I invite you to read what they had to say.

Sal

Sal grew up during the 1960s in a newly integrated neighborhood, as the youngest in a large family. While they were perhaps the "first Blacks on the block," Sal remembers his neighbors were "quite pleasant. We never had any racial disparities. They invite us

to their house. They was over at our house. We play with their kids. They play with us." Sal's family was very strict about schooling, and "schools were very important to my mother and father." So much so that if his parents weren't home the older brothers kept watch "and they stood there to make sure we did our homework. You can't go outside until you do your homework. That's one of the rules."

Sal did really well in elementary school, especially in math. When he first arrived in junior high school, they placed Sal in accelerated classes separate from his friends and from his twin brother.

> I kind of a little bit rebelled… not doing the work. My parents were upset with me and I say, 'I don't want to be here.' They say, 'Oh you smart.' I don't want to be here; all my friends are over the other classes. They looked at *me* different. So I kind of rebelled a little bit so I can get out of there… They put me in the class with the rest of my friends. My mother, my parents they wasn't upset cause they knew where I was coming from. They say, 'I know how you feel, it's scary.' I said, 'Ma, I don't want to be with these eggheads.' They try to- my friends, they treat me different. My own brothers treat me- my own twin brother was in the other class. I say, 'Why? Why should I be away from them?'

At 13 years old, Sal did not want to be treated like an "egghead," which he defined as a "nerd" who was "always thinking about schoolwork." He wanted to be hanging out with his friends. "You know, you want to be with them. You want to be cool. They started wearing suede jackets in school… nerds don't do that. Eggheads don't do that." Once he was back in classes with his friends Sal felt more comfortable, and he was

"always ahead of the class. They always came to me for help." Sal was able to maintain his social status, and to keep his grades up.

Sal was bussed to a strong academic high school, even though he initially wanted to attend the local high school.

> I told my mother I didn't want to go [the school across town]. I wanted to go to the neighborhood school where all my friends were… [the neighborhood] High School was considered the city dumping ground. Anybody got kicked out of any school in the city, they had to go to [the neighborhood school]. Mother said, 'No way you going over there. Don't even think about it.' So we got bussed over to [the other school], and I loved it… It was a great school. It was, even though it was mostly White and mostly Jewish, a few people in other areas of the city got bussed over there too. A lot of minorities got bussed over there. Then we get a little bit of a, let's say, racial balance. So, I had a good time at [that school]. I learned a lot.

Sal was about a B+ student in high school. He concedes, "I could've done better, but sometimes you slack off a little bit. You want to go here. You want to go party there… We was teenagers. I coulda done a lot better." Navigating that line between doing well academically and fitting in socially carried throughout Sal's high school experience, and he recounted decisions he made in favor of one or the other. For example, Sal chose to stop playing baseball after his freshman year of high school because he wasn't focusing and his grades started falling. However, during his senior year he "failed an English class because it was my last period in that high school and I kind of cut a lot of classes. My parents were pissed."

Sal often found his niche by helping others. He discovered that he enjoyed helping others back in fourth grade, "cause one of my older brothers showed me a shortcut to doing long division, and I showed the kids this shortcut and they were like, 'Wow! This is cool!'" Sal shared another experience from his high school geometry class, years later.

> I remember a lady named Mrs. H… I'll never know how she became a math teacher. She used to have me go in front of the class and explain her lesson *for* her in geometry. Cause I was doing good in math. She said, 'Sal, am I doing this right?' I said, 'Um, let me see. You made a mistake over there.' Explain to the class what is happening. That's all, and so I'd go to the class and just say, 'What Mrs. H., what she meant was-' and I'd explain to the class what was goin' on… I enjoyed it. She was a nice lady, but she was a bit of a dip. (laughter) I don't know how she became a math teacher.

Sal still enjoys helping others with their studies. After high school he continued to help his friends in math, and to help their children in math. Today Sal tutors college students in both math and English.

> I like helping the students and teaching them math. Or helping them with English. I like really helping more students with English than I do with math. A lot of these foreign students – a lot of them – are very bright. But you think because they can't read the English language they're not as smart as they actually are. So if I help them to get them adjusted to the language so they can flourish, show them how smart they are, that's a good feeling.

Although he doesn't like writing, Sal describes himself as a "very good writer." A high school teacher Mr. B., incidentally the same teacher who failed him in English,

"showed me a way to write a paper, a format, and I still use the formats now… I think writing is boring, but I write well." Sal attributes his writing ability to Mr. B. Now that he works with college students Sal has gained a clearer perspective on his own education.

> A lot of neighborhood schools they weren't very good. And I'm lookin' at the kids coming through school nowadays coming from the urban schools. They don't have any skills. But you have some of these students coming from the White schools, they have skills. They know their times tables. They know how to write a decent paper. They don't write how they talk. These kids coming from these urban schools, they write how they talk. That's not how you do it. I'm glad I didn't have to go through their schools.

Sal reflects, "I'm glad we got bussed to a different- away from the area schools." He knew back then that his neighborhood school wasn't a very good school, but he understands more deeply now. "I mean they had their own police force in the basement. A police precinct. It was a tough school. A rough school… It had a good sports, but academically no. I wouldn't want to send my kids there." Within his own family, Sal sees the differences in outcomes. "I have cousins who stayed in [the area schools], they still don't know their times tables. They in their 40s!... I don't think they ever will!"

While Sal is grateful for his high school experience and the educational foundation he received, he also mentioned the racial disparities that existed within the walls of his school. "Most of the students in my high school were mixed. Most of the advanced classes were where most of the Caucasian. Most of the others had most of the minorities in there. And I did notice." Sal shared the following example:

I remember when we was in high school. I went to high school with a friend of mine, Jennifer M. We were very good math students. We had about the same average. Mine might've been a little bit higher than hers. When we went to high school, they placed her in a more advanced math class than I was. Why was that? I'm not gonna say I noticed it then. I notice it now.

Why was that? Racial disparity.

At the time, Sal did not realize his friend was in a more advanced class. He just attended his own math classes. After high school, he and Jennifer attended the same college and they talked about it. "And she's the one that mentioned it to me. She said, 'I wonder why you wasn't in my math class.' I said, 'I never even thought about that.'" Looking back Sal knows, "There was no reason why she should have been in a class higher than mine."

Sal immediately went away to college after graduating from high school. "Eighteen years old. First time away from home. It was party time… That was an experience." Sal learned a lot from living with different people from different places, and while he was perfectly capable of the college-level work, he never went to class. "My parents were very upset. First time I had my mother curse at me. First time and only time." Sal wasn't ready for college, but he says it was an "experience I had to go through. Came back, started working."

Fast forward seventeen years.

Sal worked for the local transit authority, and he realized he had too much time on his hands. "That's not what I wanted. My job paid well, but that's not what I wanted to do. I wanted to do something more. Something more meaningful. I went back to school."

Sal's cousin worked in the admissions department at CPC, and so she convinced him to apply. "We talked about it, and she said, 'You have to do a placement examination, see what you need, what you don't need.'" Sal took the placement exam and discovered to his relief that he did not need any remedial classes. "So I remembered some stuff from high school." Sal's cousin told him that CPC had a new math program, and he decided to go for it. "So I went from having plenty of time to having no time." Sal liked that it kept him busy.

> School then work; school and work. I didn't have a life. I mean, I was married, but social life, hanging out- nah. Been there, done that. This was more important. Had to keep my grades up.
>
> I never took more than three courses a semester. I know I had to work full-time. Didn't overload myself. I could have passed them, but what kind of grades would you get? I like getting As and maybe B pluses. I got one C+ and one B-. Those are my lowest grades in math. I said, 'Nah, nah, nah, nah, we can't have this,' so just three courses a semester… I was in school 7 years. I went part-time. I know how much I can do, what I can excel at. If I took more courses my grades are going to suffer. I didn't want that.

Sal had an assigned faculty advisor at CPC, but he was able to independently "just follow the script" of courses he needed to take.

> They always gave us a chart on what courses you had to take and I just signed up for them. Just follow the sequence. The only time I saw my faculty advisor, when I applied for graduation. Cause you had to see them; they had to make sure you went over everything… The higher you go in math courses the less frequently they offer

the course, so when they offer it I have to take it no matter what time it is… And with me in my work schedule I had to work nights. I still work nights.

Luckily the master course schedule did not interfere with Sal's work schedule; CPC did not offer courses late at night. Back when he first started at CPC, Sal had a hard time adjusting to the course work because he had been out of school for such a long time. Sal recalled, "I wanted to quit so many times!" during the first few weeks of College Algebra.

I kind of forgot how to add and subtract negative numbers. I was like, 'Oh my God, what the secret?' And I was having trouble with it. I said, 'You know something? I don't need this.' I'm going to quit. I said, 'No, no. I paid for it.' Why I didn't quit was I paid for the school, I was too cheap to get my money back. So I went to one of the professors- he's still here now. I asked him; I was having trouble with it. He gave me a book to read on how to add and subtract negative and positive numbers. So I just read the book; I said, 'Okay, I think I'm making a mistake.' I was fine.

Next topic was matrices. I never seen a matrix in my life. We didn't do that in high school. I was like, 'What the hell is this?' And I didn't know what he was doing. Again, I said, 'You know something? The hell with this. I'm going to quit.' And I thought about it again. I'm going to go talk to him. So I went to go see him, and the guy who was in front of me went to see him first with the same problem I was having on matrices. So, I'm watching him help him. I said, 'Oh,' and something just clicked what he was doing. I said, 'Oh, I know what he's doing now.' He's just doing a system of equations without the letters. And I know how to do a system of equations. I said, 'That's all he's doing?' Then he came to me and he said, 'Sal,

what can I do?' I said, 'Professor, I got you. I was watching you help and I think I know what you're doing.' Went home and pull out the homework, and I said, 'Okay.' It clicked.

Sal never had a problem with the math concepts again, although "some courses were harder so you have to study more." Sal experienced a conflict with an English professor during his second semester and ultimately dropped the class, but aside from that he moved through the rest of his courses without any true struggles. Sal learned a lot from his math coursework, but even more by tutoring other students.

Because when you learn something in class you're only learning from one professor the way they teach it. All students have different math professors who teach in different ways. So if I had a problem with the way a student was learning something, I said, 'Who's your professor?' They'd say this person; so I'd go talk to that professor and say, 'How are you teaching students this?' And they'd show me. I'd say, 'Oh okay. I didn't learn that way. I learned another way.' So I had more input on how to do different problems, different techniques. Cause all teachers don't teach the same way. So I'd learn more math by tutoring than I would do in the classroom.

Sal spent so much time in the math department at CPC that it was "like my home." Dr. N., the department chair at the time, had encouraged Sal to become a tutor because he was doing so well in class. He thought Sal could be good at it since he always helped his fellow classmates. Sal mentioned that all math majors at CPC are encouraged to become tutors. Professor P. had often told Sal, "'You could learn more math by tutoring.' He always said you should tutor to help other students, share your knowledge." Sal reflects now that Professor P. was right.

Sal got along with all of the professors and faculty in the Math Department. Since many were about his age, they understood that he worked full time to support his home on top of attending classes. Sal was extremely dedicated. "I always got the work done. I didn't want to procrastinate and put it aside." As he talked about the coursework, Sal commented ironically, "You know I like math. And you know what else is really funny? Those upper level math classes, I found they were very boring… They were very boring stuff!" Sal found proofs to be boring, but he had an especially hard time staying awake through discussions about theory. Sal stuck with it though. "I did it. I had to. Had to make my mother proud."

Sal knows CPC has a strong math major program, perhaps the best in the regional network. He didn't know that before he applied at CPC, or even when he first started taking classes, but he realized as he was going along.

> A lot of students come here to take the math courses. I had a friend of mine, he was a graduate student, and their graduate courses were courses we took as undergraduates here at CPC. He said, 'You took that?' I took this course already. He said, 'Really? As a graduate?' I said, 'No, undergraduate.'
>
> Like, wow! So I think the undergraduate program at CPC teaches you a lot about mathematics. If you go on to graduate school you're going to be ahead of the game. I remember Dr. R. was always telling us, 'Be ready for grad school.'

Sal pointed to a photograph on the wall as he said, "That man right there. He passed away. He told us be ready for grad school." Sal continued,

> He taught us a lot. Dr. R. taught us a lot about graduate school work. A lot more than math too, especially writing. You had to write like a grad student. When you

write, your writing had better be good, or they're going to tear it up. He was always teasing us. He was from Alabama. He had that old southern talk. I say, 'Oh wow, it's true.' What he said it was very true.

After graduating with the mathematics degree, Sal took two years off from school. He worked and tutored during his time off, but meanwhile, "I saw all my friends, they got their masters. I said, 'You know something, what am I waiting for?'" He earned his master's degree in higher education, and now teaches at CPC. Sal smiled as he told me, "They know who to hire."

Regarding shift from being a student to becoming a teacher at CPC. "It's a little more responsibility, you can't fraternize with your students like you used to when you was one of them. Now they're looking to you for guidance." That said, he's still friendly with everyone. "It's my personality. I get along with people."

As a teacher, Sal tells a lot of his students, "I've been where you are already. I know what the world is like." He tries to help them not only with academics, but also how to set their priorities straight so they can succeed in life. "I try to give them a little guidance, but sometimes they have to make their own mistakes. Sometimes the school of hard knocks is the best education you can have. You learn from your own mistakes." He wants to convey to his students,

You get what you put into it. What kind of grade you want that's up to you not up to the professor; that's up to you. They like to blame professors so much. I said 'No, they're telling you what you have to do. If you do it, you get the good grade. If not, you're gonna get a poor grade.' It's up to them… it's always good to have good

rapport with your professors, get to know them. Have them know you. Any problem you go to them, talk to them as a person.

Sal learned this valuable lesson as an undergraduate teaching assistant for a Finite Math class. "Teachers – they got feelings too. They're people too… they'll get back at you." That semester, Sal recalls that the teacher was strong on material but the students did not realize that. Rather than ask for help, some students yelled or cursed out the teacher throughout the semester. The students who mistreated the teacher earned a D- for the course, which according to Sal is the "worst grade you can give a student." It's not a failing grade, so "if you're going to take it again you gotta pay for it. Outta your own pocket. And most grad programs won't accept that D-. So, he got them back."

Now that he teaches at CPC, Sal reflects a lot on his own experiences and what it takes to be a successful student.

To tell you the truth, I don't think school is all that hard. If you apply yourself. It's not that hard. The thing about school is, no teacher wants to fail you. You have to give them something. If you apply yourself, they're going to pass you. If you're doing nothing, that's where you get the F from. No teacher wants to fail anybody in class… If you show you're willing to work with them, give a little effort you're going to pass, anybody can be really a straight A student, if you're willing to put the effort in. Willing to work at it. Straight A student. Of course if a course is really hard for you, you really have to bust your ass.

Sal teaches some of the remedial math classes at CPC, and so he works with students who are not yet ready for college level course work. He witnesses their classroom habits and their academic skills first hand.

A lot of these students they're coming out of high school they don't know what it takes to be a student… I remember I taught a remedial class last year. I told a girl, 'You know, you're not going to pass this course.' And her argument was, 'But I came every day.' Yes, but you sat in the back of the class and fell to sleep. She said, 'But I came every day!'

That's what they're doing in high school. You show up, you pass. So they come to college thinking that's the same way. I said, 'It doesn't work that way. You got to- you have to do *something*.'

Sal was quick to say that it does not happen in every high school, but certain urban schools do not hold students accountable. "[Students] don't know what it's like in the real world. You've got to guide them." Sal believes that "until they address that in high school you're going to have more and more students coming to class needing remedial work. They're not ready for it… it's a major problem."

Sal recently met a different student who took only one math course in high school – an accounting class in ninth grade. "I said, 'Are you kidding me?… No wonder you're taking remedial math.' Remedial math should be for students that been out of school for 10, 12 years. But it's dominated by freshmen directly out of high school." The first two remedial classes offered at CPC are Arithmetic and Beginning Algebra, which equate to third grade math and eighth grade math.

Are you telling me these kids that are coming out of high school, they can't do third to eighth grade math? No, they can't. It's certain schools in certain areas. That's the problem… That's a major problem. And it's not like these kids are stupid. Give 'em credit because they want to do better. They want to go to school. But they're totally

unprepared. I have a big problem with that. Why are these students so unprepared for school, for college work? Reading, writing, and arithmetic.

Sal really wants to know. He has focused his own research on remedial students. Sal talked at length about his family and friends, their children, and the math problems they encounter in school. From what he has seen and heard, children are no longer required to memorize the times table. He believes some of the new approaches confuse students and send the wrong message.

It's like these kids can't learn the basic math. They think these kids can't learn the basic math. They're not being challenged in school; they're being bored… You're devaluing their education. You really think they're mentally inferior! And they're not.

Sal believes that schools must do more to engage students and pique their interests. "You're just not hitting them, you're not reaching them." He exemplified that if children can memorize the lyrics to all of their favorite songs, then they can certainly learn mathematical concepts. "They got so many other distractions… with the Internet, with their smart phones, their games. So if you're going to teach you're going to have to get something that's going to get their interest. Or else they're going to blow you off."

Sal knows that everybody thinks differently, and he works hard to help his students retain the material. "They have to try… If you commit effort, I will be right there for you to give you a hand, but you gotta try." Back when Sal was an undergraduate at CPC, one of his professors often told him that math is not a spectator sport. "Can't be on the sideline, you gotta be up in there to learn it." He passes that message along to his students as the group works together through problems.

I tell my students, 'Come to the board and show me what you're doing.' Sometimes they're hesitant, but eventually they come. So I see what they're doing and honest I want them to see it because some of the students might have the same problem they're having so everybody sees it, or where the mistakes are being made. I say, 'Well, why are you doing it that? Does everybody see that?' Some students say, 'Well, I'm doing the same thing.' I say, 'Well, all of y'all are wrong. It's done *this* way.' I let them practice and they try and the next person comes to the board, 'Show me how you're doing it too.' So eventually they get more into it. Stop being a spectator and I say, 'Let's get into the game.'

Sal likes to work with his class as a community so that everyone can be a part of the conversation. He uses an instructional method he learned in graduate school called centers.

It's like while you're helping the students you keep other students engaged in something positive, so they can hone their skills. So y'all work on this problem, y'all work on the other problem, while this group here will see what you all have problems with. And see if we can catch up to the rest of them. I don't like leaving students behind. We are a class. We are a group.

Alexis

Alexis grew up in a neighborhood near CPC with her mother and an older sister, and she had a "sheltered" upbringing. She has "lived in the same building for almost my entire life," rarely went outside growing up, and to this day she mostly keeps to herself. Alexis does not know a lot of people in her community outside of family and church members. Her mother and grandmother were very involved in the church activities, and

so Alexis participated in "whatever program that they had for the young people" including community outreach and choir. "Some of it was voluntary, some of it was involuntary, but it was a part of my life." While she did not always understand her "home, school, church" routine, Alexis now appreciates the lessons, experiences, and values they instilled.

> We don't promote acting on anger, so if there was a situation where I was provoked or antagonized, I never got into a fight, I should say. And I think that's based on the fact that I was so into the church. Because they helped us to learn how to control our anger and respond in a more calmer and… logical way, instead of acting off of the emotions and anger. I think that helped a lot because anywhere you go if you feel disrespected, or if you feel like somebody's attacking you, you may tend to retaliate in a not so nice way. So I can appreciate that now.

As a teenager, Alexis went camping at least twice a year through a church program she compares to boy or girl scouts. She still goes every year, but now as the director of the program.

> It's really fun to get out of the city and experience nature away from TV and radio and all that stuff. That's really fun. It gives you a different perspective on life because it breaks you out of your comfort zone and I think I enjoyed those experiences a lot… because you know, you're accustomed to being in a comfortable bed under your comforters watching TV or whatever or on the phone, but camping you're in a tent, in a sleeping bag, on the floor. That's not necessarily comfortable, but it's certainly adaptable. So, I mean, one of the things that it taught me is that just because you never did it before doesn't mean it can't be done.

Alexis attended a small private school when she was younger, and it was "very regimented. I wore a uniform, went to school, we did a lot of work, we did a lot of homework, went to bed at 8 o'clock. That's it!" Alexis's mother was always a strong influence on her schooling.

> My mom never went above a fourth-grade education. She's from another country, but she made sure that me and my sister got an education. It didn't matter if she understood the homework that we had or not, she made sure we did it. And I think that stood out to me because it's like no matter what, you always want your kids to do better than you did.

Alexis had a competitive spirit throughout school. She tried really hard to win the school spelling bee every year, but "I was never really a good speller." Math, however, was a different story.

> From the very beginning, I always wanted to be on top, especially in math. Any time we had like oral quizzes I always had to be the first one to answer the question, and it was always right. I wasn't trying to let nobody beat me on that.

While Alexis always enjoyed math, "when I was growing up it was always perceived that math wasn't a subject that girls typically liked. It was more of a boys' subject." She speculated that teachers often "made it seem as if boys would understand it better or would do better in the subject than girls." They made little remarks, and maybe they weren't conscious of what they were doing. Alexis provided the following example.

> I think my most memorable experience with math was in eighth grade, and I was just – my teacher was just really sort of surprised, and I think the surprise might've been from the fact that I was a girl, and at that time girls weren't necessarily considered

logical thinkers or math thinkers or whatever. And I think I just blew him out the water. We were having some kind of contest. It was boys against girls, and he just kept shooting out questions, and most of them were easy, but then he started getting harder, and I just kept answering them, and he's like, 'Are you cheating?' And I'm like 'No… (pause, shakes head) *No*.' So from then the fact that he was surprised by the fact that I could do it made me want to do it even more.

Alexis was generally a good student and she worked hard in school. She transitioned to a public high school and at first was nervous for the change. "Based on the movies I've seen about high school and bullying and how they might treat you or whatever – it really scared me because I never had experienced anything like that before, and I didn't want to." However, a lot of students from her private elementary school moved onto the same high school so that made the transition easier. Additionally, "when I got there it wasn't as bad as I thought it was going to be. It's just people going to school just like me, so I scared myself more than I needed to, and it was fine." In hindsight, Alexis put unnecessary pressure on herself. She had some conflicts here and there but overall high school was a good experience. She was a cheerleader, and she had some influential teachers.

I mean, you know, you mesh with some but you don't mesh with others. But the ones you do mesh with do encourage you and do push you forward and even get a little stern with you when you need it, and I think any student needs that… The ones you mesh with I tend to want to do better in that class than the ones I don't mesh with. I don't know why we relate the teacher to the subject, but that tends to happen a lot. So if I like that teacher I'm going to try to do my best in that class but if I don't like the

teacher then I really don't care. And I see that more portrayed when I was in high school than anywhere else.

Alexis did not like history during high school but her math teachers were all cool, so "it was easy for me to continue to develop that love for the subject." So much that she joined the math team at her school. "I think I was only on it for like one semester. We used to meet early in the morning, 7 o'clock in the morning to go over- to do math drills, but we never competed." Alexis is not sure why they never competed, "but because we didn't do anything during that time, I just dropped it."

While "there were very few occasions where I wasn't doing so well," Alexis recalls that high school did have its ups and downs.

Sometimes – at times – there were a few times where I was influenced in the wrong way. And, you know, I used to cut class and stuff and to do nothing, which made no sense… I guess that was just me trying to fit in with who was cool or whatever.

But it doesn't make any sense to me now because education was free back- you know, it's free in high school. You gotta pay when you go to college. It's a totally different experience. And to cut class then and think that it was so important to do so to fit a certain crowd, doesn't make any sense to me now because you need as much education as you can get, especially if it's free, because that's invaluable when you look at it.

Alexis thinks differently about these things now, but deep down she always knew how valuable an opportunity was for her to attend high school.

I was a part of the generation that actually got to go to high school, so that was a little pressure for me there. And then from high school to go to college that was even more

pressure because, you know, the numbers get smaller and smaller. Like, I was one of the very few who did do that, and my whole entire family was always looking to see what was I doing and how I was doing. That annoyed me a bit. I think that's what took me so long to finish college.

Immediately after high school, Alexis attended a highly selective college in the same regional system as CPC. Alexis did not necessarily want to go to college at the time, but her family expected her to.

When I was 18, I wasn't really interested in going to college or trying to figure out what I was going to do with the rest of my life, so I thought it was a waste of time. I went because my mom told me I had to. And I'm supposed to listen to my mother. But, I didn't see the importance of it. I didn't think it was going to make a difference.

Alexis was a social work major for about two years before she withdrew. She worked at an elementary school for a while. Three years later Alexis realized she would need a degree if she wanted to continue teaching kindergarten, and so she decided to go back to college.

I thought I was going to be good with just my high school diploma, which is weird, but that's what I thought. So, the first time I started college was totally different than the second time. Because the first time I really didn't know what I wanted to do, I didn't know where I wanted to go, I didn't know what classes I wanted to take… But when I came back- when I started the second time, I came to CPC and I started as a education major, and then I transitioned into math.

Alexis originally had a concentration in mathematics at CPC and so she had taken several math classes by the time she transitioned into the major. Alexis explained what prompted her decision.

> I got 'suaded. I was in my Calculus II class, and I think it was Dr. N. who came and was talking about the math program… He said, 'You become a math major and then you get a job tutoring because you have to keep the math fresh, and then you get a laptop.' And I was like, 'What? I'm going!'… I said, 'Well, I might as well. I like math, and I don't like none of these other classes,' (laughter) so I changed my major. And that was it.

From there, her college experience changed drastically.

> When I was a education major, I went to school, I did what I had to do, and I went home. I didn't go to the library, I didn't do any extracurricular activities, I didn't talk to anybody, I didn't try to make friends, I just wanted to do what I had to do and go home. But when I switched to the math – being a math major, it was much more interactive because we were required to be tutors, and with the classes that I was taking, I had to make friends in order to have study groups, in order to understand things that I wasn't getting in class. We were able to bounce ideas off of each other, and solutions and stuff, which made the experience much easier than trying to do it by myself. Because I've always tried to do everything by myself, but that doesn't work, because you live in a world with other people.

At first Alexis found it awkward to form new friendships in the math department at CPC because she had kept mostly the same friends since she was a small child. It eventually became easier to open up, "especially since you know that we're all here

trying to do the same thing, which is accomplish something that is pretty much great. So thinking of it in that aspect really changed my feelings towards it."

Alexis spent a lot of time at CPC. "Let's say I was here probably from like ten to five or so… if I wasn't in class then I was in the math department either tutoring or working on whatever assignment we had at the time." She did all of her homework on campus because she had a family at home. "When I left here I would pick up my daughter from the babysitter… when I got home it was dedicated between my daughter, my husband at the time, and whatever else I needed to do." There was not much time in the evenings. "There was so much time dedicated to doing college stuff," but Alexis reflects that it had to be that way.

> I think that when you're in college there are very few life experiences that you have outside of it because college becomes your life. Especially if you want to get the good grades and you want to gain something, you want to accomplish, that you want to get your degree, you want to be the best you can be… it becomes your life. But that's just how it has to be for a student. I mean, you can only get out what you put in and if you don't put in enough you're not gonna get anything that you want at all. It takes time and it takes persistence.

Alexis talked about her experiences with the math classes at CPC, and how she progressed through the major.

> When I first came here I started off from College Algebra, and because I was always good in math, the Algebra, the Trigonometry, and Pre-Calculus – all that was very easy for me. A breeze. Even up to Calculus. Up to Cal II. Calculus II… pretty much smooth sailing. But when I started getting into classes that dealt more with

theory and proving theorems and stuff, that's when it started to get a little more challenging for me. Because applying formulas and computation and stuff like that, that's just like second nature. But to understand where they came from and to prove things yourself, really took more than just calculating on a piece of paper. So when I started getting into the core classes and the math major, that's when things got really real. (laughter)

It made me question myself and wonder if I really wanted to be a math major still or not. Only because the classes made you think of things in a different way, and when you're… so accustomed to thinking of things in just one way, you expect everything to just be like that, and that's not life. So it really brought you out of the box, but- with the study groups and with- one thing about CPC, especially the math department, what I can say is that they really do help you when you ask for help. Like, we were able to go to any professor no matter if they were our professor for the moment or not, we were able to go to any professor from the math department, sit in their office, ask questions, and really get an explanation. That helped tremendously, because if it was just left up to me I probably wouldn't've finished. So that was a great support for us.

The math faculty and professors had an open-door policy and Alexis found them to be extremely approachable. "So if it was math, or even if it wasn't math, they were always there to answer questions or help in any way that they could and it was sort of like my second family." While it was always that way, Alexis did not realize it or accept it until she was in the upper level math classes. "Because, not everybody is a math major, and

some of my classes they were only like maybe five people. So the smaller the groups were, the more of a family it felt."

Alexis took a year off from CPC after she had her daughter, and she was afraid she might fall behind and lose her place in the community. "I didn't want to get lost… because I started with a different group of people, I didn't wanna come back and feel like I was left behind that group of people." When she returned, Alexis was relieved to find that she was not so far behind her classmates and friends. "Even though there were like, a few that did advance faster because of the year that I took off, I didn't feel out of place." Alexis felt a sense of accomplishment from that, and she was determined to stay on track.

> I remember the last year I was in school, I only had math classes left, so I ended up taking six math classes one semester, and five the second. Only because I wanted to graduate on time. The way they do the math classes here is: if it's offered in the fall, it's not offered in the spring. And I didn't want to keep waiting years and years for them to keep re-offer it for the next year. So six in the fall, five in the spring. Everybody told me I was crazy, but I was determined to come out of here. I didn't want to spend another two years waiting.
>
> It was intense. It was really intense. It was a little bit of a blur, (laughter) but a lot of the courses that I took were electives… the electives weren't as regimented as the core classes, so there is a little more room and space to breathe.
>
> But I had no choice. I had to do it.

Looking back on her college experiences, Alexis shared the following thoughts about her successes as a math student:

Practice. That's the only way.

I'm a huge procrastinator, and I always leave things for the last minute, and it worked in high school completely. But... it worked in college in some classes but when it comes to your major and those classes that you need for your major it doesn't work for that… Like you just can't study for the test, has to be a ongoing process. Everything is connected. There's no way I could just study for one test and think it's never gonna come back again. Everything is built on the previous. So it's always a progression but you always have to have the foundation there, always, you always have to remember it… Everything has to be revisited and gone over again and again and again and again.

Alexis also reflected about her overall experience as an undergraduate student at CPC.

I don't think I would change anything about it. I met some really good people here, especially like Dr. R., who passed away a few years ago. He was awesome. Like the notes he gave, the insight he gave, the advice he gave. They *really* resonated with me. Only because he made sense. I don't think I would've had the same experience if I went somewhere else. And I think I was meant to be here, so I'm grateful for that.

Just a few miles away and a few years earlier, Alexis had an entirely different experience at her first college.

The air just seems so thin. I don't know. I felt like I couldn't ask anybody no questions, I couldn't relate to anybody there. It just felt – I felt – I felt extremely out of place, and I think that's one of the reasons why I stopped going in the first place. Not to say that it's not a good college or it doesn't offer great things; it just wasn't for

me. And I think that's one of the reasons why it took me so long to go back to college in the first place, is because of that experience over there. And that's not to say that somebody said something to me or did something to me that was wrong. It was just – that was just how I felt. But when I came here it was – everybody was way more relatable. I felt a whole lot more comfortable. I don't know if it was just a mental thing or whatever or something that I just made up out of the air, but that's how I felt.

Alexis still tutors math at CPC, and she teaches some of the remedial math classes. Alexis understands some things now that she didn't when she first started as an undergraduate student.

Now that I've graduated and I tutor the math there's a lot of things that I understand way more now than I ever did when I took a class, especially my Pre-Calculus. Which is funny because I did well in all of my math classes but now that I tutor it, it's a totally different experience and I think I appreciate it more now than I did then. There's not pressure for me to have to know the information in order for me to take a test and get the answers right. There's no pressure. So I can appreciate it for what it is.

Alexis had always done pretty well in school, but it was different once she got to college. She quickly figured out that she was on her own. She reflected on her personal college preparation, and how she believes things have changed over time.

When I was younger and I went to school, we were responsible for doing work and our homework and stuff, but our teachers, my teachers really babied us. Like, they gave us everything. We didn't have to look for anything, it was right there. When

you come to college, nobody's trying to do that for you. And it's like a cold water splashing your face. Like, it's either you do the work or you don't. And if you don't do the work you fail, there's no 'I'm gonna give you another chance, another chance, another chance.' It's not there. Not to say that it should be, because you have to be responsible for your own educational experience, but it's totally different.

And I think it's worse now because a lot of students that I come in contact with that are coming straight out of high school, they don't know how to read properly, they don't know how to write properly, and a lot of them have to do remedial math and remedial English. I think that there was a breakdown somewhere, and not to blame just one entity because I believe it comes from your parents, yourself, your school, your society, it's all everything in one but something was lacking where there was no push for them to do better or motivation for them to do better because when they come even if, and even as they are in remedial, they're still about- they're just about the phone and being on the phone. And not to say that all of them are like that, but a lot of them are. There has to be some kind of bridging the gap between showing up just to be present and actually showing up to do the work… And I think that the mentality has changed drastically.

Alexis has worked with the Math Department at CPC for a while, and she ultimately believes that success is up to the individual student. Someone else needs to provide a solid foundation at a young age, "but at the end of the day, when you become an adult all your decisions are yours. Nobody else can make the decision for you, so your success is yours, your failure is yours. You gotta own that." Alexis wishes more students would come for help when it is offered.

I think we really do try to help as many students as we can that come for help. But the ones that come for help are just a small, tiny portion of the ones that need to come for help. So, I don't know what else we can do, or what else we can say to attract more students to come for help, but I don't know, I think we gotta think of some new ways to attract them here. Because the ones that do come and do take advantage of the opportunity, they benefit. They do, they really do. And you can see them progress class to class to class. And they always come back, 'Help me, help me'… and it's a good feeling. But I think it just needs to expand a little more.

While speculating on whether students know the help is available, Alexis concluded, You know, I think they do. But every time that I make an announcement about it everybody's so shocked and surprised. But I'm like, I'm sure I said it yesterday! (laughter) So I think people hear what they want to hear. And, you know, (taps table) it's always up to them. It always is.

Trevor

Trevor grew up in a tight-knit, "typical church family" with three brothers and both parents. Trevor was an independent and "antisocial" child; he attended church events with his family although he did not "really want to go out to any particular place but once they got me out I would be polite, answer questions when asked and… just count the minutes till (laughter) it's time to go." He preferred to stay at home with his brothers, their video games, or his music.

As a young child, "I used to love school, especially mathematics. After doing my first equation and knowing this made sense, I knew math was my subject." Trevor was

recognized for his mathematical abilities in third grade, when he got to participate in an accelerated math program.

> I was nominated to take part in a mathematic program where students would move at their own pace. So, you would read the textbook, once you finish a section you're given an exam, once you pass the exam you could move onto the next session. I really enjoyed that, I was moving forward… the experience was great. It exposed me to a lot in mathematics and… it basically inspires students to excel at their own pace. You were allowed to go all the way up to calculus from elementary school. So, it wanted to see how students can do on their own. Either within groups or… just with minimum lectures from professors… It was pretty much that program that really help me [excel in mathematics.]

Trevor thrived in this environment because he liked to do things independently. Trevor participated until it was time to take an outside exam to qualify for another accelerated program at a local college, but he missed the exam date; it slipped his mind. Trevor views this as a "missed opportunity but it wasn't too bad" because he found similar opportunities later in junior high school and high school.

Some of Trevor's most poignant school memories come from fifth grade. His teacher Professor B. conducted his class with a reward system where he gave out comic books to students, "and I really enjoyed that atmosphere." On a more personal level, Professor B. "saw the potential in me… and he used to inspire me. He always wanted me to do a little extra." Professor B. once told Trevor, "this is your ticket," as a way to encourage him to use his intelligence and to maximize his academic potential.

That same year, Trevor developed a habit that would haunt him throughout his academic life: procrastination. Incidentally, he traces it back to a specific day in class. "Our professor, he gave us an example. And before he finished I had my hand up with the answer and he pretty much told me 'Wait, let everybody get a chance.'" Trevor took Professor B.'s advice literally; he slowed down to nearly a halt. "I used to want to be ahead of schedule… Everything must be done on timely basis, and correct. After a while it was, 'You have time.'"

Because the academic part of school was easy for Trevor, he never had to put forth much effort. "Attend class, do the assignments, you pass… It's basically if you opened the book (laughter) you will pass with an A, at least for me. All I usually do is, if I read the text I would know the material." This meant Trevor could get away with procrastinating and postponing his assignments. "I remember back in my high school years, my friend he said, 'The normal student will wait 'til the last minute. I will wait 'til the last second.'"

Trevor smiled knowingly as he said his mother continues to remind him of Professor B.'s words from so many years ago, "This is your ticket." Trevor's parents have always pushed him to pursue his education.

> One thing with my parents. They believe education is number one. In fact, they don't want me to stop… they want me to go for my PhD and then worry about all the other things that come in life. And the same goes for all of my other brothers. They feel that no one could take what you know from you. So once you're educated you're knowledgeable, you're set. Regardless of what anyone wants to do to you, they cannot take that from you.

Trevor's parents helped him a lot with homework during elementary school – "more reading and writing" than mathematics, but beyond that Trevor never asked for help. "I wanted to do things on my own... I was antisocial and I felt people should depend on themselves, and rely on others as minimum as possible." Trevor's parents saw that his grades were good, so they "never really said anything to me." That is, until his high school junior year.

> At the end of the semester they got the report card, and… all failing grades. So. I recall that same day just praying that I just want it to be over.
>
> After I received the report they called up my parents because I would be on academic probation, or possibly removed from school. I recall my mother, father going up, they were with the guidance counselor for days. They would've gone to extremes… fight to make sure that the school wouldn't kick me out during that bad semester… they made sure that I continued, that I didn't have any breaks.

Trevor had slacked off completely. He instead had dedicated his time and energy toward helping his friends and classmates with their assignments. "After that I just told myself I have to apply myself. Can't always help everybody else and forget about yourself." Trevor explained that semester as a wake-up call, and he got back on track quickly.

> For me… it was a little nerve-wracking. I didn't need them to be involved for so long and then all of a sudden they're involved. That's what also added to the wake-up call – that I have this philosophy or motto that you could do things on your own and now… I had to be dependent again.

Besides that one semester where I decided to slack off completely, school was pretty much the same throughout. Attend class, do the assignments, you pass. And… (pause) there weren't really any big challenges.

Trevor speculated that school probably felt the same throughout because he attended a high school/early college where he could choose classes from a course catalog, whereas a general high school might just "give you a list of courses you have to take." While talking about challenges, Trevor did provide the following caveat about both high school and undergraduate studies:

I did not like writing essays. Since I'm so intrinsically in mathematics something what we call elegance, it's short and straight to the point. So when we come to English class and they're telling us to write three-, ten-, five- page papers to talk about something, the plot of a story or what's the underlying message, I could always – well normally for me I could state all of that in one, two paragraphs. And… it was just a hassle.

Trevor took no time off between high school and college. "My parents told me I have to be in school (laughter)… I waited 'til the last minute to apply for college, and CPC was close." He described his first day on campus, and his near-seamless transition into college level course work.

I believe I was in a computer science course, data structures. And we were sharing the room because this, it was actually a elective… data structures course. So we were sharing the room with another class, it was the operating systems class. And from day one the professor was asking questions about operating systems and I was

participating. That's what really drew others to me, a new person already capable of answering and participating in a higher-level course.

And then the next stop, next thing was in mathematics. I went to [the] Math Department and I just noticed some writing on the board and decided to help students, and that's how the mathematics occurred. Uh, R. (laughter) He just took me to the side and said, 'What major am I taking?' and told me no, I'm taking mathematics.

Initially a computer science major, Trevor was helping a classmate during a Calculus III class when Dr. R. asked him to join the mathematics program. He almost immediately signed up because of his "inability to say no" and he later graduated with the mathematics degree and an associate degree in computer science.

Trevor found the undergraduate experience to be similar to high school. He knew the system: attend class, complete the assignments, and take the exams. "Math just flows for me, so as soon as the topic was approached and the steps were stated I could follow and I moved on." Trevor spent his time in class "waiting for the homework so I could hand that in and the exams so I could take them." However, one math course captured his attention:

Dr. S. enrolled me in Set Theory and that one was also straightforward but it was a little different. Because with Set Theory I kind of learned more about how these functions came to be and additional terminology associated with them.

That was enlightening… what I normally like is knowing the definitions so I could always derive. It provided me with the definition of what functions are and how sets are related to function. So I could formulate better… especially computer

science when I'm writing applications, dealing with mathematics or any various other sciences.

Trevor was most interested in courses and opportunities that he could apply to his goal of becoming a computer scientist. He enrolled in a summer research program through the Computer Science department during his first semester at CPC. "It's a weather balloon launch program where you collect ozone samples in the stratosphere and troposphere, to determine if the ozone layer's depleting." Trevor participated in the program for several years, during which he helped with nearly all aspects of the preparation, launch, retrieval, and data analysis. Not only did Trevor gain valuable field experience, but the research program grant covered his tuition. During his final year at CPC, Trevor found an IT job off campus and paid his tuition out of pocket.

While he never found the course material to be challenging, Trevor eventually fell back into his old study habits.

I think probably with Complex Variables… I think I was becoming lazy. It wasn't so much that the math was difficult. I wasn't reading. Or listening that much in class so if you haven't covered the topic you can't really do much. But the topic, it wasn't too difficult. I don't think any class was difficult… I started slacking off again. So… I didn't read the material, I didn't really do homework… on time, but I started picking that back up.

Trevor is not sure what prompted his old habits, but he procrastinated in other classes and situations too.

Instead of doing what I needed to do I would… stall like for instance the History. I probably withdrew from History three times before I decided to stick to it. Also there

was a time during the summer I took an English class, and the same issue happened. I forgot to hand in the final paper and I stayed with a incomplete for a couple days before I resolved. Well, a couple semesters before I resolved that. So my biggest obstacle was honestly myself. I didn't do some work and that slowed down my progress.

Trevor wishes he had continued with the momentum he had during his first year at CPC. "At the beginning my objective was to finish early so I usually attended five classes. And there was one semester I even managed to get around seven." Trevor described a typical day at CPC as "usually class, tutoring, class, tutoring or hanging out, class, class, and towards the end tutoring." He got home each night, where he was still living with his parents, at about 9 or 10 o'clock. A few years in Trevor took a semester off from his studies, and he ultimately graduated from CPC in five years.

As he mentioned, Trevor withdrew from History several times before he finally completed the class. The professor ultimately approached Trevor, and the two of them made an agreement.

Give him half, that's all he needs.

The professor I had – he basically realized that in class I interact well, I was a part of all the discussions. It's when (laughter) assignments were needed he noticed that I would stall. And, this only with those assignments because the in-class assignments he said they were great, perfect. It's just the other assignments… the projects, they were slow.

Outside of class Trevor became preoccupied with tutoring and he believes that also slowed down his personal progress.

> Initially it was full throttle, aiming for my goal then I started taking on the loads of others. I became really popular… as one of the main tutors around. So it was, a main focus was me for probably the first two years, then it was other students.
>
> I was not only tutoring with the school, I was tutoring outside and I was pretty much accommodating other people. So during my breaks between classes I would be with students. And even after school, after I'm finished with all my classes I'm usually with students until late.

Trevor tutored for the math department at CPC, but he eventually stopped working at the school to tutor students privately. He helped students with mathematics as well as physics, computer science, and chemistry. Trevor put out flyers and typically met with students on campus or at the library. A lot of students responded and at first it worked out well.

> But then… they noticed that I am nice, sympathetic, so they started to take advantage of that. Like, they know they're coming for two hours, they would say that they forgot their wallet or they didn't have the right amount, or they want to negotiate pricing. Other thing is, they will call you or text you at the last minute stating that they will be late, and come hours later... And so towards the beginning it was great, at the end it… was the inconsistency with the students, either with payment or attendance, basically they were not taking my time seriously so I had to… tell them they would have to go elsewhere.

Perhaps soured by his experiences with tutoring, Trevor described CPC as a "standard social community" with politics. "Every individual although they will converse with you, there is the look like they are measuring you up, see how much you could give to

them and allow them to achieve." Trevor only experienced that with people who were outside his group; he also developed close friendships within the math and computer science departments. Some friends even helped Trevor out when he needed it.

> It was consistent with some friends like C… if she notice that there's something I needed to do, she would say, 'Hey. Just fill out this paperwork and I'll get everything done.' So with some people it was frequent… Basically they realized my, what I call habits (laughter) and they anticipated that I would need certain things. So they just helped out.

While he would never *ask* for help, Trevor was grateful to have friends who offered it and helped make sure he stayed on track. "It was pretty nice… You feel a sense of comfort in that there are people looking out for [you] and not everyone was trying to take advantage after all."

Trevor also enjoyed pleasant relationships with professors and faculty. He shared that at CPC, "if you have a mentor they usually stick with you. They are truly helpful." Dr. R. was Trevor's mentor in mathematics. "[He] passed away but we had a great relationship. He would actually call me over when he was writing his letters to the school and we… (pause) We spoke." Trevor had a close relationship with his first computer science mentor, Dr. B., who sometimes took him underwing. "I used to TA his classes, grade papers and… we would normally before class have a little conversation about where I'm gonna head afterwards and basically some current events." With Dr. A., the head of the Computer Science department, "We would usually converse from time to time to discuss what we're gonna do with the program and what I should be doing." Trevor referred to his English and History classes when he said, "because I did stall a

little to leave." Through ongoing conversations and encouragement, Trevor's mentors helped him move forward in order to finish the degree.

Looking back, Trevor believes that he experienced "a stereotypical undergraduate life," except he does not think many students tutor or participate in research projects – simply because "they don't do the research. It's like if you look for scholarships, plenty are out there but no one really looks." Instead, students work while they go to school and maybe they do not realize that scholarship and research opportunities exist. However, he believes colleges should do whatever they can to expose students to relevant industries and avenues for financial support.

> The one thing students do worry about when they're in college is, 'How am I gonna pay for next semester?' And, another thing you always have is the loans I have to pay after I'm done. And you don't really feel too secure that, 'Is this degree going to actually get me a job that could help me pay off the loans?' So if colleges could expose students to job opportunities, internships, scholarships so that they'll feel more secure.

Trevor is extremely analytical, and he always has been. In order to exemplify this innate personal quality, he explained his life-long decision-making processes around his personal and career goals and how those fit in with someday starting a family. Trevor also synthesized his views on college and education. "The degree itself is just a piece of paper. It's just like a license… I was always cynical of degrees… that could be done by simply taking a test."

Trevor explained that if a graduate school just wants you to know certain concepts, a test "would make people assume that you already know the material that would have

been covered in your undergrad. So there's no need to really spend all of that money and time relearning most of the things you already know." Barring that option, Trevor still believes that "college could be more."

> I feel undergraduate is a little bit of a repeat of high school… For instance the whole core curriculum is English, History, some basic mathematics, those are things all, every student should have done. Back in high school. What college undergraduate should have been is probably a semester of exposure to each of the fields so a student will know what, which field they want to pursue, and for the latter part they will be more exposed, something more than the basics.

Depending on what field a student decides to pursue, colleges could offer certification courses or in-depth training so that students will leave college entirely prepared to enter the industry. "For instance if you want to be a data [analyst], what a undergraduate course could do is the following. They expose you to SQL and various platforms. Another thing they could do is, make you analyze databases." Trevor maintains that simple programming queries and finding basic averages – the sorts of concepts and skills that he encountered in his undergraduate college courses – aren't enough to provide students a stepping stone in the workforce.

Having said all that, Trevor understands that not every student graduates high school with the educational foundation he received. Trevor knows that knowledge is power, and he feels that his own early exposure to higher level mathematics sparked his interest and aptitude in programming and mathematical sciences. Trevor believes that unless children are exposed early to "all the possibilities they could pursue" including arts and sciences, then they eventually enter college lacking the basics. They will barely absorb the

material they learn in class, and thus find it much more difficult to pursue higher levels of education.

> Elementary, so that we could expose children to all of this advanced material early. Make sure they know the basics so that we no longer need remedial programs in colleges. Another thing, parents should definitely be involved. In fact, the community should be involved… What I want them to be exposed to is the arts, the sciences definitely. Every child should at least know, besides knowing at least two languages, they should at least be exposed to mathematics, up to the calculus level, and statistics as well as chemistry or physics or biology. It's necessary. There's so many epidemics out there, these viruses, if we have more children, at a younger age, being exposed to what really forms viruses and what they are, by the time they get to college, they'll be capable of figuring something out. Because of early exposure, they get a understanding of how it, the structure works, so as they develop and children are so much more creative than adults… they would probably think of a way that we ourselves are not familiar with that could actually help us.

Evan

Evan was the middle child in a large, close-knit family with both parents at home. They lived in rough neighborhoods with a lot of street activity, and Evan "didn't allow the environment that I lived in… ever affect anything that I did. I was always my own person, my own guy. Whatever I felt was right I did, and whatever I felt was wrong I didn't do." Both of Evan's parents were ministers and he has been deeply involved in social and spiritual church activities throughout his life. When Evan was younger, his

mother was a member of the Parent Teacher Association at his neighborhood elementary school. He remembers the influence of

> having my mom being there at the school and pushing me at home so it was like the same thing. It was like at home there was a push, in school there was a push, by my mom [and] the teachers and then at church, and outside life there was still that same push… They're all saying the same thing so it's like there's no room for you to get a mixed message. It's like everybody's saying and talking the same thing.

Evan enjoyed elementary school, and he had caring elementary educators who planned fun competitions and held him and other students to a high standard. He mentioned the impact of

> having teachers who understood where they're teaching, which I think that's an important aspect, understanding the demographs of the individuals that were coming into your classroom. They weren't judgmental, they did everything that they could to make sure that we all had a understanding of the material… even when there was a challenge, there was always a way in which they taught that it made it to where everybody understood what was going on and everybody was able to excel together.

While he received his educational foundation in elementary school, Evan's love for mathematics developed in junior high school. By then he knew he wanted to be an accountant and so he chose a high school with a specialized program for accounting. However,

> When I first applied… I didn't get in… I was on like a waiting list. So I had to go to [a different school] for one semester and my experience there was just horrible… it was like the teacher really couldn't get through any of the material, they couldn't

> teach us anything because it was always just a group of disruptive students. You had students just running around in the hallways, interrupting class, pulling fire alarms, it was just always something every day... and I told my mother, 'Listen, I can't do this. I literally can't do this.'
>
> And so I applied… again… in January… that's when they pick up the spring semester. So once the fall was – I think it was right after Thanksgiving break, we reached back out… and I spoke to one of the counselors, he brought me in, they looked at my grades and everything and they were like, 'Okay. We'll allow you to come here for the Spring.' So I was just like, happy at that point like, 'Yes! I'll get outta here.'

Evan adamantly wanted to reapply immediately, even though the school typically made students wait until the following year to reapply. Because his sister happened to attend the same high school a few years earlier, she knew who to call at the school. This combination of Evan's persistence combined with guidance from his family and community are woven throughout his childhood and schooling memories. For example, Evan recounted a conflict he had with a junior high school science teacher, the fallout after his mother intervened, and the help he received from a different teacher. The science teacher

> had got so mad with the class that in his anger he threw down a particular scale or something, and then after that instead of having a real science class it was, 'Okay read the book, answer these questions. I don't want to hear anything, I don't want you to talk to me.'

> I didn't like it. I was very upset about it… I came home and I told mom, 'He doesn't- we don't learn anything.' So then how does he come up with these grades that he gives us, and for me I've always been the type of student where I always wanted to do well.

After Evan received a low report card grade, his mother approached the teacher for an explanation. When it seemed the teacher had no basis for the grade, Evan's mother complained to the school administration. "And the backlash of that, it was like every time I came to the class it was always a confrontation between me and him and not necessarily because I made it." Evan found himself frustrated and angry in class, which in turn caused more conflict with the science teacher. Evan's dance teacher, on the other hand, was "one of those teachers where… whatever it was, you could sit down, you could talk, you could do work if you stayed after school." It helped that she always kept candy and snacks in her desk.

> [During this particular incident] she was able to just come in and talk and provide the other side. 'Okay, you don't want to do this because… this is not helping to benefit that. You're actually playing into the dynamic that he's talking about with the students that he has in his class.' Plenty of people said it, it didn't go off for me. She said it, it went off. And it was just like I said, because of who she was and how she dealt with us that it made sense. It made the connection.

This teacher had the same demographic identity as Evan, and perhaps because of that "there was a different understanding… she just had a tone and I guess she talked our language a little more… she just knew how to speak to us and to get us to understand." He described her and another teacher as "integral in getting through junior high school."

Evan attributes one of his most valuable lessons to a high school chemistry teacher who always encouraged group work in class. During an instance when things weren't going so well for Evan's group, the teacher sat with them and guided them toward a solution so they could get back on track and finish the project effectively. "Up until that point I don't think I really understood group activity and group work and what it entailed and responsibility for your part… he was really able to just break down to us how to flow as a group." This lesson in group dynamics proved invaluable after his sophomore year at CPC, during a summer research internship in Arizona. Evan remembers the pressure he and his cohorts felt to finish their group project despite critical feedback and a looming deadline. While Evan was able to get through the experience, a few other students "said, 'Hey, I can't take this. I'm out.' And they got back on the plane and went back to wherever they came from." Evan appreciates that "just understanding that group dynamic at a younger age really matured me at a older age to be able to handle."

Evan enrolled at CPC 18 months after he finished high school. During that time his SAT scores expired and so he could not yet gain acceptance to his first-choice college. Evan never even applied to CPC; the school sent him an acceptance letter and he decided to attend while waiting for his other paperwork to come through. Evan signed up as an accounting student and he intended to earn 30 credits before transferring to another college. "I was on my way out. Bad way to think but that's just how I thought about it." Things started to converge for Evan during an Algebra class with Dr. R., who would ultimately become his mentor.

> I answered one question for him inside the classroom and he was like, 'I need to talk to you after class.' I'm like, what did I do? I didn't do nothing wrong and he was

like, ‘Well what’s your major?’ And I told him and he was like, ‘You’re a math guy. You’re a math guy.’ And I go to church and the following week the preacher said the same thing. ‘You’re a math person.’ And I’m like, ‘Wait, what. Did y’all talk to each other? What’s going on here?’

Evan soon began helping classmates outside of class and “it was just like everybody would gravitate to me to help them and they said, ‘You should teach, you should be the professor!’ And I’m like, ‘I’m not gonna teach.’” Dr. R. stayed on top of Evan. “I registered for Pre-Cal that next semester… The professor said my name and they were getting ready to go to the next name and they stopped… They said, ‘You know Dr. R?... He said to come to his office.’” Evan was impressed not only that Dr. R. remembered his name, but that he took the time to pursue him in that way just because he wanted Evan to pursue math. Evan changed his major at the end of that semester.

When Evan first started attending CPC, he worked full time at an insurance agency, but after a time he came and worked as a tutor in the math department. From then on, Evan “literally lived in the math department of CPC, all day.” A typical day was twelve or thirteen hours, “never a moment where you weren’t doing anything,” whether he was attending class, tutoring other students, working, or even helping professors teach their classes. Evan spoke at length about his experiences as a tutor and how the role changed as he advanced through his studies as a mathematics major.

Especially in the beginning, Dr. R. when I was tutoring would just be standing around. Or Dr. P. And they’re listening. They’re listening to my explanations, they’re listening to how I’m articulating the material. And sometimes the way in

which I was articulating the material – wasn't anything *wrong* with it, it just- it wasn't how they were teaching it in the classroom.

Evan learned early on that while it was good to show an alternative way to understand the material, it was more important to first demonstrate the same approaches and terminology the professors used in class. Sometimes Dr. R. or Dr. P. would quickly interject during Evan's tutoring sessions. Later on if Evan demonstrated a concept to a student "and it wasn't necessarily right," Dr. R. assigned him extra work.

> 'No, go to the board and grab that book.' It had 60 problems. 'And you're gonna stand there and do all 60 problems until you get it.' And it wouldn't take 60 problems for me to get it cause I got it the second or third time, or I got it right then and there when he said it. But, because he wanted to make sure that that was *in* me and that I wouldn't forget it, it was, 'You gonna stand there and do 60 problems.' I mean that was for Cal I, Cal II, Cal III and even my upper level classes. It was just that type of thing.

Once Evan enrolled in advanced math classes, his tutoring role extended to leading study groups for those classes. However, often "because it is upper level, I'm learning, it's not like I know it and I'm giving it to them. It's like, we're in the same class and we're learning the same material and I have questions about this thing too!" Evan's role as a peer tutor deepened his teaching skills and "really shaped me as a student," because Evan learned to explain new material in the moment while he was at the board figuring it out for himself. His study group worked at length through challenging material before they approached the professors with remaining questions and so "by the time we got through with Dr. R., Dr. P., doing a whole bunch of problems, you were good."

The math classes at CPC were always challenging, but Evan enjoyed the experience. Dr. R. taught most of the upper level classes, and his curriculum binders were "full of problems to definitely get you to think outside of the box… in a way that you definitely need to as a mathematician." Evan's other classes including Probability Theory, Linear Algebra, and Differential Theory, were taught by other professors and were equally challenging. "They always gave you questions that you could literally sit there and debate with them about it… things that you thought were straightforward and easy sometimes definitely weren't very easy."

Dr. R., an older gentleman, "would be tired all day and somehow he just got this energy to just keep on going and… that's when he became alive, when he was teaching those upper level classes." A class that was supposed to run for two and a half hours on a Friday evening would extend to three or more hours, "but nobody was gonna tell him no." Dr. R. even occasionally taught classes pro-bono if CPC tried to cancel due to low enrollment. "So how you gonna have a senior class run and it's only three of us that are graduating, and you want 6, 7, 8, 9, 10 possible students? These students have to graduate." Evan explained that had Dr. R. not extended this personal gesture and sacrifice, some students might have had to push their graduation terms back an entire year.

Because he spent so much time in the math department at CPC, Evan felt comfortable approaching almost any professor with math-related questions. However, Evan emphasized the strong and trusting relationship he built with his mentor. Dr. R. had an open-door policy, which meant Evan did not need office hours see him. Dr. R. not only helped Evan through the logistical aspects of college such as staying on track with

required coursework, but he helped Evan understand how to be a better teacher and student through his ongoing mentorship, impromptu lessons, and conversations. Dr. R. trusted Evan to help teach certain classes, and he helped Evan secure an out-of-state summer internship opportunity. Dr. R. was also available for personal conversations, and at times he helped Evan navigate both family-related and school-related circumstances that made it difficult for him to persist.

For example, one semester Evan's financial aid fell through and he was ready to drop his classes because he could not pay out of pocket. Dr. R., who happened to be the deputy chair of the math department, advocated for him. "[He] was literally on the phone with everybody… when they got to the bottom of it, it was just a error on their part." They reinstated Evan's financial aid, and Evan still feels blessed that his mentor stepped in to help. "Had I not had somebody like that in my corner, who knows what would've happened?"

Evan has a reason to speculate; he once witnessed a friend from the biology department trying to resolve a similar situation on her own. Everyone in the waiting area watched as she spoke with several financial aid officers and then finally left in frustration; she took two semesters off. Evan asked almost rhetorically, "I got mine worked out, why couldn't she get hers worked out? Is it just because I knew a mentor, I knew somebody who knew somebody that was able to call and get that straightened out?" Evan strongly believes that every student should be able to attend school if they have the desire and work ethic, and he hated to see that people were unable or unwilling to help make things easier.

Evan experienced a lot of personal successes during his undergraduate years. He was identified as a leader among his peers to lead workshops, and professors trusted him to cover their classes (including upper level math classes) during their absences so they wouldn't have to cancel. With that, Evan talked about a personal obstacle.

> I excelled in math; I did not excel in English and language. So what would happen is that I would be in an English class and I would think I was doing good and I would find out at mid-term I wasn't doing as well as I wanted to and I would drop the class… And I would register again and I would drop the class. And then it got to the point where now I'm towards the end of my graduation term and now I have three English classes that I have to do which means now I have to spend a year and a half to do it.

Evan realized this at the beginning of his senior year. He could not take two classes concurrently. "It was like, 'No, silly. You weren't thinking. You just were thinking about getting good grades. You weren't thinking about the fact that you need to sit here for three consecutive semesters and get this done!'" Because of this, Evan had to delay his graduation. "It wasn't that I was frustrated with the class, I was frustrated with myself. Like, how could I allow myself to do that?"

> I did all my other requirements. It was like, you did research. You did your senior seminar and (laughter) you had this English class to go to. And so there was really three writing class that I was literally taking at the same time. I don't like writing, so it was just really frustrating for me. And even in writing research papers it was like, okay I love the research. I love doing what I gotta do. But I don't feel like writing the whole thing up!

> [It] wasn't that I couldn't write or I didn't know how to write. It was – as you went to different English class everybody just showing you or telling you that the way that you're writing is wrong and you need to write like this. It was like, you spent all semester trying to write like this, to go to the next class and they say, 'No! Don't write like that no more, write like this!' And so I was just like 'Okay, (laughter) this is confusing.' It's not like math. We accept both, as long as it's proven mathematically, we're good.

Accordingly, Evan had a hard time staying motivated and on task. He relied on his friends in the math department to help him push through those English classes. "I think I said to C. and different ones that were around – I was like, 'Look. Ask me about English every other day. Please, whenever you see me, ask me about English.'"

Evan now teaches at CPC. As a student, "I saw slowly and surely that this is what I wanted to do." Once he felt that passion, Evan started to watch his professors closely. "Okay, he's a good teacher. I need to know everything that this guy knows. I need to pick up on why does he do things like this." Evan notes that a lot of his instructional approaches come from Dr. P. and Dr. R. simply because he worked alongside both professors so much as an undergrad. He just naturally started incorporating their strategies into his own teaching personality – but really Evan brings everything he has learned into his teaching, all the way from elementary school.

Evan sees himself as a role model and a mentor for other students. Because he is young, he can relate to the younger students on a different level and they're drawn to him a little more. "They're like, 'Oh, how did you do this?'" Evan tries to make sure he's knowledgeable so that he can help others find success in whatever they want to do.

What I try to do is the same thing they did for me, help others understand and see the bigger picture and things. Lot of times I got the lesson, I got the understanding but I didn't necessarily see the bigger picture. It wasn't until [later] you kind of look and be like, 'Oh, okay so that's why had me sitting on the board writing for like five hours on a day.'

You appreciate it now. And especially you appreciate it when they're not here anymore.

One of the most motivating lessons Evan learned from Dr. R. did not sink in until he experienced it firsthand. Evan now works to instill the same important lesson in his students.

When I left as a undergraduate from CPC one of the lessons that I was taught by my mentor was, 'Listen, you're able to go to any school, I don't care whether it's Princeton, Harvard, Yale and you can compete on a level with these guys. There's no reason for you to feel intimidated because you come from a small HSBC [*sic*] called CPC.' And I can reflect on that because I remember going to CAARMS[4] conference with Dr. P. and there was all these Princeton students that were there, and Howard and all these big names and they were talking about things and I'm sitting there like, I really felt like out of place but then… after downtime and just talking I realized that they were just individuals just like me. And they had a social life and everything wasn't just math and they talked basketball and they did different things, and a lot of the things that I thought they understood about what was going on, they didn't… And in that moment I understood that okay, ya. You know enough math to talk at a

[4]Conference for African American Researchers in Mathematical Sciences

> level with people who are supposed to be quote on quote, on a different level than you by, society and by where they rank in top schools. So I would say that was definitely motivation for me to just keep doing what I'm doing which is just to keep teaching, keep learning and just letting students know that regardless of your skin color, regardless of where you come from or how well you learn you're able to compete with the brainiacs of the world. It's just about who you are and how much time you put into preparing yourself to work at what you want to be in. So I would say that's motivation.

As a teacher and as an alumnus, Evan reflects deeply on what he has experienced and witnessed, and what he envisions. His generation of alumni have often returned to CPC. "There's alum that come back all the time and just share what's literally going at other institutions all across the world." For example, Evan told the math department that they ought to offer GRE classes, as well as other programs and technologies he saw at other colleges and research programs. "You're not doing a service by not having us doing these things. Especially if you got students that want to do applied math." Evan is pleased to see the CPC Math Department making progress, and he believes that with updated curriculum, new technology, and more research opportunities the math program will become even more attractive to future students.

> Like their motto was creating success one student at a time and I'm like, 'No! You can't do this one student at a time!' We have to be able to create an atmosphere where a lot of students excel and move forward with their career goals because at the end of the day we become alum for this school.

> On one level, you could say this is only an undergrad program… but then it's all about when you put the time into developing your students, then you have stronger alumni that can come back and help you develop stronger students, and that cycle just keeps continuing and then you graduate stronger alumni. And that cycle just keeps going on and on and on.

Chapter 4 Summary

In the qualitative tradition, the data that appears in the counternarratives above include thick description and the participants' own voices. More importantly, they illustrate the richness and variety of participants' experiences as they navigated childhood, schooling, college, and beyond. Sal, Alexis, Trevor, and Evan each shared their personal stories, reflections, and beliefs with me. I am honored to have presented their stories here.

Chapter 5: Analysis of Findings

This chapter presents an analysis of the findings from this study, which explored the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution. The study began with four three-part interviews conducted with Black graduates from CPC, an under-resourced PBI in the eastern United States. Details regarding interview procedures and data analysis were presented in Chapter 3. Chapter 4 presented findings in the form of counternarratives.

To analyze the findings, I considered each participant a case and I conducted within- and across-case analysis. I organized the themes according to the research sub-questions, and I presented these themes as they emerged from the participants' experiences, perspectives, and beliefs. I connected the themes back to the primary research question after the discussion of findings, which will be presented in Chapter 6.

Research Questions

The primary research question anchoring this study was: What are the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution? This study also sought to answer the following sub questions:

- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their life and schooling experiences?

- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their undergraduate experiences?
- What factors do Black women and men who have earned their degree in mathematics from an under-resourced PBI perceive to be associated with success in earning the mathematics degree?

Theme Identification

To identify themes in the interview data, I relied primarily on Creswell's (2013) three steps for qualitative data analysis. These steps include (1) preparing and organizing the data, (2) reducing the interview data to themes through coding and condensing, and (3) representing the data in a discussion of the findings.

Once I prepared the interview data, I first read the interview transcripts twice in their entirety: once while listening to the audio recordings, and a second time without the recordings. As I immersed myself in all the interviews, I gained a sense of each interview as a whole and of each participant's entire testimony. During the second reading I read the all of the first interviews, then the second interviews, and finally the third interviews respectively in order to gain a sense of the experiences of the participants as a whole. During and after the second reading I noted ideas and key concepts in the margins and in a notebook as they occurred to me (Creswell, 2013). This helped orient my thinking before I uploaded the transcripts into *nVivo* so I could begin to organize the interview data into initial codes.

I started with prefigured categories from the literature review, which represented information that I expected from this study, which explored factors associated with persistence and success in earning the mathematics degree at an under-resourced PBI.

Some of these prefigured categories, which I used only to inform and structure my initial coding process, included (1) *personal characteristics*, (2) *community*, (3) *family*, (4) *college community*, (5) *academics*, and (6) *institutional context.* After initially coding the data, I had 49 unique categories in *nVivo*. Some emergent and additional categories included (1) *church*, (2) *schooling*, (3) *math major*, (4) *perceptions*, (5) *beliefs*, and (6) *society*.

Creswell (2013) describes the coding process as iterative, and I worked through his notion of an analytic spiral as I reviewed and revised categories throughout the coding and condensing process. In an attempt to exhaust each coding category, I ran multiple word and phrase searches within *nVivo* before categorizing and condensing the codes. In some cases, it made sense to place a coded reference within two categories. For example, a reference about how a math professor helped with tutoring might fit under the "CPC" subcategories *tutoring* and *CPC faculty*. I kept detailed memos in my Data Analysis Notebooks in order to track my thoughts and ongoing interpretations, because I sometimes un-coded certain categories to help make better sense of the body of interview data. This underscored Creswell's (2013) notion of a cyclical process that requires the researcher to keep memos and reinterpret and reclassify coded data again and again.

Ultimately, the coding and categorizing process resulted in 315 codes under 12 categories and 36 subcategories, as outlined in *Table 3*, which was included to summarize the coding structure I used to make sense of the data to help identify themes. The information in *Table 3* does not intend to imply relative weight to any codes or categories. For example, the fact that the category of "CPC" had the strong majority of subcategories and codes does not mean it was more important than "Perceptions,"

"Nontraditional student," or any other parent category. Creswell (2013) cautions against making assumptions about code counts within qualitative research; accordingly *Table 3* merely summarizes the structure I created in *nVivo* to help make sense of the interview data during this phase of analysis.

Table 3: Data Coding Structure

Categories	Level 1 Subcategories	Level 2 Subcategories	Total Number of Codes
Academic identity	None	None	3
Childhood influences	None	None	6
Community	None	None	12
CPC	12	6	143
Church	None	None	8
Family	1	None	15
Nontraditional student	None	None	7
Perceptions	7	1	55
Personal characteristics	1	None	25
Personal reflection	3	None	41
Schooling	4	1	56
Society	None	None	9
Undergraduate not CPC	None	None	8

At this point I paused to write the participants' counternarratives, which were presented in Chapter 4. This served two purposes. First, I felt it was important to reorient myself with each participant's story in order to appropriately distill themes for this study, which relied on within- and across-case analysis (Ayres et al., 2003). The coding process, while important, decontextualizes participants' individual voices and effectively separates the data into units of meaning (Ayres et al., 2003; Stake, 1995). I reread each participant's transcripts, and then I isolated some of the already coded data in *nVivo* by case. As I read through categories such as *family*, *influences*, *academic identity*,

schooling, and *personal reflection*, a vivid picture of each participant began to emerge. I recoded these and other significant statements as *memorable quotes*, and from there I used Seidman's (2013) process of intuiting to engage with each participant's story and reconstruct the counternarratives.

The second purpose was to conduct member checks before moving forward with the next phase: theme identification. It was important to ensure that I had appropriately and effectively captured each participant's personal, academic and social experiences, perceptions, and beliefs before analysis and interpretation. To derive themes from the categorized interview data and resulting counternarratives, each participant was considered a case and data were analyzed by cross-case analysis (Ayres et al., 2003). I tried many different relationships and sorting schemes, referring to and revising my data analysis notes throughout the process (Creswell, 2013; Lichtman, 2006). I repeated this process until a few significant trends and ideas emerged, and I then classified those trends into general themes. My goal was to establish five to seven salient themes (Creswell, 2013), and I ultimately organized sets of themes around each of the research sub-questions which centered on life history, the undergraduate experience, and beliefs about persistence and success. This aligned closely with the Seidman (2013) interviewing structure and the ways in which participants verbalized and reflected on their experiences.

It is important to note here that within- and across-case analysis achieves a somewhat paradoxical outcome: it enables the researcher (and reader) to interpret the participants' individual experiences in a generalizable way. While coding and condensing themes works to capture commonalities, this process might undermine the uniqueness of the

individual cases (Ayres et al., 2003). A certain degree of generalization was important to address the primary research question for this study. Still, it was important to maintain the integrity of each participant's unique and valuable perceptions and experiences. I sought to balance these sometimes contradictory goals as I analyzed the findings and presented themes that subsequently emerged from this study.

Themes

The themes presented represent only the reflections and meanings shared from this study and are not meant to be generalizable to other populations. Nevertheless, these themes are a means for PBIs, Minority Serving Institutions and other institutions that educate similar populations of students to continue the conversation on the meanings the mathematics degree earners give to their undergraduate college experience.

I present the themes using a metaphor of navigating a long and sometimes unpredictable river, which I believe captures the spirit of the participants' experiences. I will explain how family, educational, personal, and community influences and experiences contributed to participants' persistence and success in mathematics at various phases of their educational trajectories. These influences and experiences are discussed in three phases: (1) life and schooling experiences, (2) undergraduate experiences, and (3) beliefs about persistence and success. These phases align with the Seidman (2013) phenomenological interviews, and with the research sub-questions from this study.

Overarching Metaphor that Describes These Participants' Experiences

Throughout the world and throughout history, some people's lives and livelihoods have depended on navigating large and unpredictable rivers. It can be a long and arduous

journey. However certain tools, connections, and knowledge can ease the same journey physically, mentally, and emotionally. Consider the Mississippi River.

> The Mississippi is well worth reading about. It is not a commonplace river, but on the contrary is in all ways remarkable... It seems safe to say that it is also the crookedest river in the world, since in one part of its journey it uses up to one thousand three hundred miles to cover the same ground that the crow would fly over in six hundred and seventy-five.
>
> *-Mark Twain, Life on the Mississippi (1903)*

From its source at Lake Itasca to its mouth in the Gulf of Mexico, the Mississippi River stretches 2,230 miles. With its hundreds of tributaries, the Mississippi River watershed covers nearly 40% of the continental United States and is laden with idiosyncrasies. Parts of the river have spontaneously changed course in a matter of hours, thereby isolating communities or moving entire towns across state lines. Different segments of the river have unusual currents and tidal swings, flood plains and mud deposits. The river deepens and narrows as it makes its way downstream, which makes it ever more difficult and dangerous to navigate. Not to mention the near-mythical Mississippi Delta. The mouth of the Mississippi creeps slowly south, leaving stagnant bayous in its path. In order to successfully navigate this river, a person would have to understand its geography and sometimes unpredictable behavior. It helps to know someone who has navigated the river before.

One might equate a river like this to the American P-20 education system, with its infinitely complex and dynamic systems and structures. The long and arduous journey from childhood through degree attainment is laden with known and unknown obstacles a student might encounter along the way due to the implications associated with systemic policies and practices, which lead toward intended and unintended consequences. Stops

along the way might be considered educational milestones, and someone's goal might be to reach the City of Memphis, Baton Rouge, or the Gulf of Mexico. A person could become disoriented or exhausted any time or anywhere along the journey. That same person might persist for the entire journey. From childhood and schooling years through college, the participants navigated their educational paths or journeys toward the mathematics degree in ways that were neither linear nor predictable. They perceived their pursuits as personal and yet influenced by others who helped supply knowledge, tools and connections that made the journey easier (or more difficult) in both tangible and intangible ways.

In general, the participants' experiences began in neighborhoods not too far from CPC within tight-knit families who were engaged in their social or spiritual communities. They all had supportive parents who instilled educational values, encouraged their success, and advocated for them at certain times during their elementary and secondary schooling. As they navigated their K-12 schooling years, the participants found influential teachers who recognized their mathematical abilities, pushed them to excel, and sometimes exposed them to other mathematical opportunities.

After joining the mathematics program at CPC, the participants encountered a network of student cohorts and faculty members who helped them academically and logistically as they navigated the path toward graduation. The pursuit toward the degree was discrete and personal, and some participants were more independent than others at certain junctures. Yet all of their journeys were situated within this distinct and important community of learners and supporters. Despite perceived obstacles and challenges, or times when they were steered off course or even stuck, the participants had

access to enough helpers, supporters, and positive influences along the way that they continued the journey to success.

In the next sections of this chapter, I present ways in which family, educational, personal, and community influences and experiences contributed to participants' success and persistence in mathematics at various phases of their life and educational journeys.

Life and Schooling Experiences

Participants highlighted key roles their parents, teachers and communities played in their success in schooling and mathematics, particularly during the elementary years. The roles their parents played were multi-dimensional and spanned throughout their K-12 schooling years. They encountered caring and influential educators, as well as teachers whose actions or words impacted their educational journeys in surprising ways. Participants had access to mathematical experiences and learning opportunities that impacted their later enjoyment or success in mathematics. In this section I present these and other themes that emerged (See *Table 4*) when participants discussed their life and schooling experiences.

Table 4: Themes that emerged when describing *Life and Schooling Experiences*

Theme	Evan	Sal	Alexis	Trevor
Family involvement and advocacy	x	x	x	x
Teacher influence	x	x	x	x
Negative	x	x		x
Peer influence		x	x	
Math	x	x	x	x
Beyond local community	x	x	x	x

Family Involvement and Advocacy

All four participants grew up in homes and communities where school and education were extremely important. Sal's family was strict about schooling, and Trevor grew up with the deeply engrained understanding that "education is number one. Once you're educated you're knowledgeable, you're set. Regardless of what anyone wants to do to you, they cannot take that from you." Evan felt the message from home, school and church: "They're all saying the same thing so it's like there's no room for you to get a mixed message. It's like everybody's saying and talking the same thing."

They heard the message loud and clear. One theme that emerged from the interview data was *Family Involvement and Advocacy* throughout the participants' elementary and high school educations. Evan's parents were directly involved throughout elementary school, especially since his mother was a part of the PTA. "It felt good to know that they cared and- I was appreciative of them being there for certain moments." His family later guided him through the process of applying to a specialized high school. Evan initiated the process, but his sister and mother advocated for him by calling the school to inquire about the appropriate paperwork. Trevor's parents helped out with homework when he

was younger but they left him alone once they realized that he was doing well. Sal, Trevor, and Alexis's families all made sure they completed their homework, and they were always watching to make sure they performed well in school. Sal's mother ensured that he attended a competitive high school. Sal's "parents were pissed" when he failed an English class in high school, and Trevor's parents went to extremes to advocate for him when he fell behind and was placed on academic probation during his junior year of high school.

Teacher Influence

Another theme that emerged from the data was the influence teachers had both academically and personally. Evan talked about the early impact of

> having teachers who understood where they're teaching, which I think that's an important aspect, understanding the demographs of the individuals that were coming into your classroom. They weren't judgmental, they did everything that they could to make sure that we all had a understanding of the material. (Evan)

While Alexis talked about some of her high school teachers:

> I mean, you know, you mesh with some but you don't mesh with others. But the ones you do mesh with do encourage you and do push you forward and even get a little stern with you when you need it, and I think any student needs that. (Alexis)

Evan and Sal remember all of their teachers, while Trevor does not remember many at all. But all four participants recalled certain teachers or classroom interactions. The teachers that stood out were the ones who saw their potential, recognized their abilities, or whose words or actions had a lasting impact on their educational journey. Evan's elementary teacher Ms. B. and principal Ms. N., who "would always strive for us to do

more than we thought we were capable of" both helped to shape the type of learner and teacher he became. Trevor's fifth grade teacher, Professor B., inspired him and pushed him to excel but at the same time his advice to "let everyone else have a turn" sparked Trevor's lifelong habit of procrastination.

Sometimes it was a more personal touch. Evan's junior high dance teacher "just knew how to speak to us to get us to understand, and that was the most important thing." Similarly, Sal talked about Coach L., who would help smooth things over for students that had trouble with the regular gym teacher. "He was the only teacher I had sign my yearbook."

Some participants also encountered negative experiences with teachers. Interestingly, they mentioned these experiences in passing or combined these with positive experiences and influences. Evan had a conflict with a junior high science teacher, yet his dance teacher helped tremendously with that situation. The English class that Sal failed during high school? That same teacher taught Sal how to be a proficient writer, a skill he now appreciates and enjoys helping others acquire.

Mathematical Experiences

All of the participants spoke extensively about the role mathematics played throughout their schooling experiences. Trevor captured it when he said, "I used to love school, especially mathematics. After doing my first equation and knowing this made sense, I knew math was my subject." Alexis put it this way:

> I knew that math was what I like, the subject that I like the most, and even though I did, I knew that from elementary school, I didn't necessarily put it into action until I

got to college. But it definitely spark my interest and I don't think that I would've become a math major if I didn't like math so much when I was younger. (Alexis)

They all enjoyed math from a very young age and they performed well academically. *Table 5* presents these and other sub-themes that associated with *Math*.

Table 5: Sub-themes associated with "Math"

Theme	Evan	Sal	Alexis	Trevor
Enjoyed math	x	x	x	x
Did well in math	x	x	x	x
Recognized for ability		x	x	x
Encouraged to excel	x			x
Math extracurricular activities			x	x
Helped others		x		x

During their schooling years, three of the participants were explicitly recognized for their mathematical abilities. Back in third grade, Trevor was nominated to participate in an accelerated math program. This exposed him to higher level math concepts up to calculus, and Trevor was even given the opportunity to take a higher level exam to qualify for a college program.

Alexis and Sal's teachers also recognized their mathematical abilities, but their experiences were a bit different.

We were having some kind of contest. It was boys against girls, and he just kept shooting out questions, and most of them were easy, but then he started getting harder, and I just kept answering them, and he's like, 'Are you cheating?' And I'm like 'No… (pause, shakes head) *No*.' (Alexis)

Alexis knew the teacher had underestimated her because she was a girl, and that made her want to excel even more in math. She later joined her high school math team but dropped it after a semester when the team never entered any competitions.

> I'll never know how she became a math teacher. She used to have me go in front of the class and explain her lesson *for* her in geometry. Cause I was doing good in math. She said, 'Sal, am I doing this right?' I said, 'Um, let me see. You made a mistake over there.' Explain to the class what is happening. (Sal)

Sal enjoyed teaching the class when his Mrs. H. didn't know what she was doing. "I mean that kind of led me to be more of a math tutor, helping other students in math. Led me to the path I'm in now." Still, even though Sal was a strong math student – strong enough to teach his high school class – he was placed in a lower level math class than his White friend who had earned similar grades. "Why was that?"

Beyond Local Community

As children, all of the participants' academic or social experiences extended beyond their local neighborhood communities. Whether it was by personal choice, family choice, or a combination of the two, each participant is grateful for these experiences and the opportunities they afforded. The sub-themes associated with *Beyond Local Community* are outlined in *Table 6*.

Table 6: Sub-themes associated with "Beyond Local Community"

Theme	Evan	Sal	Alexis	Trevor
Church	x		x	x
Private school			x	
Choice high school	x	x		x

Evan socialized outside his local neighborhood community – partly by his own choice and partly because his parents ensured he had other places to go. He grew up in some rough neighborhoods with street activity where it wasn't always safe to play outside. Though always cordial and nice because they were his neighbors, "I kind of stuck to myself, I realized that I couldn't necessarily hang out and be friends that everybody that lived on the block or around the block." Instead Evan's parents took him and his siblings elsewhere to socialize, whether to church or to be with extended family. Trevor and Alexis also chose not to socialize within their local neighborhoods. Trevor described himself as an introvert who preferred to spend time alone and Alexis also mostly kept to herself. Alexis does not know many people in her community even though she's lived in the same building almost her entire life. "I mean there were people who looked out for me but that was because of my cousins."

All three of their families were part of a church community, though Trevor only attended social church events to be polite and please his parents and aunts. Evan and Alexis, on the other hand, have been deeply involved in social and spiritual church activities throughout their lives. They both were part of choir and community outreach programs, and they both participated in events and trips. Alexis and Evan grew up to become leaders within their church communities.

All four participants attended a school outside their local community, whether it was their decision, their parents' decision, or a combination. Alexis was sent to a small, "very regimented" private elementary school. Trevor, Sal, and Evan attended college preparatory or specialized high schools. Sal was bussed across town, away from the neighborhood schools so he could get a stronger high school education. "Mother said,

'No way you going over there. Don't even think about it.'" Looking back, Sal is glad his mother made that decision for him. "I mean they had their own police force in the basement. A police precinct. It was a tough school. A rough school… It had a good sports, but academically no. I wouldn't want to send my kids there."

Evan caught a semester-long glimpse inside his local high school before his family helped him reapply to a specialized high school, and he didn't like it. It was hard for him to learn among "just a group of disruptive students. You had students just running around in the hallways, interrupting class, pulling fire alarms, it was just always something every day."

Trevor had this to say about his experiences growing up:

> My experiences as I was growing up allowed me to at least not fall, become a statistic, I would say. It kept me away from unnecessary crowds. When I came here [to CPC] I was only exposed to people who wanted to do something with their life. So even though some negative atmosphere or environments were around, as I was growing up I wasn't exposed to that, I didn't want to be exposed to that. (Trevor)

Summary of Life and Schooling Experiences

The experiences these graduates reported throughout their K-12 schooling years embrace the notion of childhood protective factors that contribute toward educational resilience (Williams & Bryan, 2013). Their positive family relationships and parents who provided an education-oriented upbringing set the participants up for success as they navigated school. These supportive parents instilled educational values, encouraged their success, and advocated for them. While some of their schooling experiences brought forth questions about course placement, teacher quality, cultural mismatch, educational

access, and hidden assumptions (Nieto, 2010), the participants' parents mitigated these factors through advocacy and engagement (Martin, 2006). The participants from this study also encountered influential teachers who recognized their mathematical abilities, pushed them to excel, and sometimes exposed them to other mathematical opportunities. This corresponds with the high achieving Black mathematics students from Ellington and Frederick (2010), who attributed some of their college success to the early family support and mathematical experiences and opportunities they were afforded during childhood. In addition, the participants' social communities or activities extended beyond their local neighborhood communities. These acted as buffers to the environmental factors they might have encountered in their local neighborhoods or schools (Williams & Bryan, 2013).

Undergraduate Experiences

The next phase of these participants' academic journeys was their undergraduate experiences. As undergraduate students at CPC, the participants accessed faculty support, tutoring and other leadership opportunities, study groups, and peer support systems as well as internships and research opportunities. Access to these support structures was instrumental to these participants' success as mathematics majors at different times and to varying degrees.

While all of the participants attended and graduated from CPC as mathematics majors, none of them joined the CPC mathematics program directly after high school. In this section, I present themes that emerged as participants discussed their undergraduate college experiences. These themes are outlined in *Table 7*.

Table 7: Themes that emerged when describing *Undergraduate Experiences*

Theme	Evan	Sal	Alexis	Trevor
Life-school balance	x	x	x	x
Tutoring	x	x	x	x
CPC Faculty	x	x	x	x
Classes	x	x	x	x

Life-School Balance

All of the participants encountered personal circumstances or situations that impacted their decisions on whether and when to attend college, or on whether to remain continuously enrolled. Sal and Alexis went to different colleges years before they decided to enroll at CPC. Sal was not ready the first time he went to college, and he waited 17 years before going back to school. Alexis did not see the importance the first time she went to college.

> I thought I was going to be good with just my high school diploma, which is weird, but that's what I thought. So, the first time I started college was totally different than the second time. Because the first time I really didn't know what I wanted to do, I didn't know where I wanted to go, I didn't know what classes I wanted to take. (Alexis)

Alexis enrolled at CPC 3 years after leaving her first college. Evan waited 18 months after high school before enrolling at CPC. Trevor enrolled immediately after high school, but he later took a semester off from his studies to regroup before earning his degree.

> I think (sighs) people should actually resort to working on themselves before helping others because if you do so you're holding yourself back. As a result of that I was actually taking a semester off instead of moving forward. (Trevor)

Evan almost had to take a semester off because his financial aid fell through at the last minute. Fortunately "when they got to the bottom of it, it was just a error on their part."

Alexis and Evan both became parents while pursuing their math degrees at CPC. Alexis took a year off to take care of her newborn daughter, and she returned to finish the degree. During her final year Alexis overloaded on math courses so that she could graduate on time. After Evan's daughter was born, he found a new way to balance his role as a father with his life as a student. "I was able to with the help of family and others that were here. Sometimes it meant having to bring my daughter and sit in class or leave her with C. and I just did my thing." It also meant working extra hours in the tutorial department at times.

While attending CPC, the participants maintained busy schedules. Sal worked full time while attending CPC because he was supporting himself and his wife at home. He was a part-time student, though he spent so much time in the math department that the faculty became like a second family. "School then work; school and work. I didn't have a life." The other 3 participants spent long hours every day at CPC. A typical day lasted anywhere from 8 to 13 hours and it included attending class, tutoring other students, working in the math department, assisting professors with their classes, studying, and maybe getting something to eat. Evan "literally lived in the math department" and for Alexis "there was so much time dedicated to doing college stuff." There was very little down time, even at home. Alexis had a family to take care of, and Trevor and Evan did not get home until 9 or 10 o'clock each evening.

These experiences, circumstances and situations that impacted the participants' schedules, priorities, and overall *Life-School Balance* are consistent with those of non-traditional students, who are more likely to attend PBIs and Minority Serving Institutions similar to CPC (Markle, 2015; Radford et al., 2015). *Table 8* delineates the non-traditional characteristics that emerged for these participants, as reported during their interviews.

Table 8: Non-traditional student characteristics that emerged during participant interviews

Characteristic	Evan	Sal	Alexis	Trevor
Delayed enrollment	x	x	x	
Attended part-time		x		
Employed full-time	*	x		*
Has one or more dependents	x		x	

*during a portion of their studies at CPC

Tutoring

Not only are math majors encouraged to tutor other math students at CPC, but they're paid for it. All four participants tutored in some capacity at CPC, and all except Trevor benefitted personally from doing so. Trevor became so preoccupied with helping others through tutoring that it hindered his academic progress, but he acknowledges that tutoring reinforced some of the methods he now teaches. Tutoring is centrally located in the math department, in an open space just a stone's throw from most of the professors' offices. People could walk by and easily listen in if they wanted to. Sometimes Dr. R. or Dr. P. would quickly interject during Evan's tutoring sessions, and over time Evan really honed his own teaching skills. Sal often approached the professors if he wasn't sure how to demonstrate a concept, or how a student was learning in class.

> All students have different math professors who teach in different ways. So if I had a problem with the way a student was learning something, I said, 'Who's your professor?' They'd say this person; so I'd go talk to that professor and say, 'How are you teaching students this?' And they'd show me… So I'd learn more math by tutoring than I would do in the classroom. (Sal)

Evan sometimes led study groups as a peer tutor for his upper level classes. At times, the professors would join and answer questions if the entire group was struggling with a concept, and everyone in the group gained a deeper understanding.

> And by the time we got through with Dr. R., Dr. P. doing a whole bunch of problems, you were good. So it really helped shape me as a student as well with doing the peer tutoring. (Evan)

For Alexis, tutoring kept the math fresh even after she passed the course. Now that she's graduated, Alexis continues to deepen her skills as a mathematician through tutoring.

> I did well in all of my math classes but now that I tutor it, it's a totally different experience and I think I appreciate it more now than I did then. There's not pressure for me to have to know the information in order for me to take a test and get the answers right. There's no pressure. So I can appreciate it for what it is. (Alexis)

CPC Faculty

Some words that came up when describing the *CPC Faculty* were family, listen, open-door, helpful, personal, goal, together, mentor. While not every faculty member possessed every one of those qualities – and some may have possessed zero of those qualities – each participant encountered professors and other faculty members who

enhanced the undergraduate experience at CPC. Whether it was somebody who took interest and became a mentor, or just somebody who noticed a place of struggle and helped in that moment, participants spoke again and again about people within the CPC community who taught, listened, advocated, gave lasting advice, or otherwise helped in meaningful ways. While much of the data was situated within the math department, these conversations and interactions happened in other contexts as well.

> [They] really do help you when you ask for help. Like, we were able to go to any professor no matter if they were our professor for the moment or not, we were able to go to any professor from the math department, sit in their office, ask questions, and really get an explanation. (Alexis)

When Sal first started at CPC he had not taken a math class in 17 years and so he understandably needed to brush up on some of the concepts. He went to talk to the professor twice in two weeks. "[The professor] came to me and he said, 'Sal, what can I do?'" Sal got the help he needed and never had another problem with the math. He still talked with professors often because of tutoring and learned a lot through those conversations. Similar to Alexis, Sal and Evan found an open-door policy with the professors in the math department.

The faculty helped beyond academics. During his first semester, one of Trevor's computer science professors connected him to a research opportunity that not only covered his tuition, but it also gave him valuable field experience. Evan's mentor helped connect him to a summer research opportunity, and he also advocated for Evan when his financial aid fell through. "[He] was literally on the phone with everybody," before Evan's aid was reinstated so he could continue his education.

Faculty and mentors were available for personal conversations, and they truly listened. Trevor articulates, "if you have a mentor they usually stick with you. They are truly helpful." Trevor's three mentors helped him stay on track as graduation approached. Evan's mentor stayed after-hours to offer personalized lessons and advice, and Alexis appreciated that "if it was math, or even if it wasn't math, they were always there to answer questions or help in any way that they could and it was sort of like my second family." The math department also became like family to Sal. "I love the people here… I'm comfortable here."

Dr. R.

Of all the faculty members at CPC, Dr. R. came up most often and most meaningfully. Perhaps it's because he individually recruited Trevor and Evan to join the mathematics program, which essentially changed their academic trajectories.

> I went to [the] Math Department and I just noticed some writing on the board and decided to help students, and that's how the mathematics occurred… He just took me to the side and said, 'What major am I taking?' and told me no, I'm taking mathematics. (Trevor)

> I answered one question for him inside the classroom and he was like, 'I need to talk to you after class.' I'm like, what did I do? I didn't do nothing wrong and he was like, 'Well what's your major?' And I told him and he was like, 'You're a math guy. You're a math guy.' (Evan)

Or maybe it was because the students could feel how passionate he was about teaching. "He would be tired all day and somehow he just got this energy to just keep on going and… that's when he became alive, when he was teaching those upper level

classes." A class that was supposed to run for two and a half hours on a Friday evening would extend to three or more hours, "but nobody was gonna tell him no." (Evan)

It could also be his wisdom. Dr. R., an older gentleman, was an accomplished mathematician and a gifted writer. He sought to connect his undergraduates to the world beyond CPC.

> Dr. R. taught us a lot about graduate school work. A lot more than math too, especially writing. You had to write like a grad student. When you write, your writing had better be good, or they're going to tear it up. He was always teasing us. He was from Alabama. He had that old southern talk. I say, 'Oh wow, it's true.' What he said it was very true. (Sal)
>
> [One] of the lessons that I was taught by my mentor was, 'Listen, you're able to go to any school, I don't care whether it's Princeton, Harvard, Yale and you can compete on a level with these guys. There's no reason for you to feel intimidated because you come from a small HSBC [*sic*] called CPC.' (Evan)

Alexis encapsulates it here, as she talks about the people she met while studying at CPC:

> …especially like Dr. R., who passed away a few years ago. He was awesome. Like the notes he gave, the insight he gave, the advice he gave. They *really* resonated with me. Only because he made sense. (Alexis)

Dr. R. helped establish the mathematics program at CPC, and in doing so he designed much of the original curriculum for the department. Evan echoes Alexis's sentiment about Dr. R.'s notes.

> [His] notes were just definitely like, to this day people will still ask do you have his binder on notes for this class, whatever the case because they were just so logically put together that it literally was in the way that you would think about how to do a problem. (Evan)

Classes

Classes comprise a huge part of any college experience, and participants had a lot to say about the classes at CPC, and the logistics of working through the requirements in order to graduate. A final theme that emerged about the undergraduate experience was *Classes*. The participants generally found the lower level math classes to be straightforward. Once Sal realized how to compute with integers and to work with matrices, things clicked for him and he never had any problems. Alexis also had an easy time with the foundational classes.

> I started off from College Algebra, and because I was always good in math, the Algebra, the Trigonometry, and Pre-Calculus – all that was very easy for me. A breeze. Even up to Calculus. Up to Cal II. Calculus II… pretty much smooth sailing. (Alexis)

Trevor had a similar experience. "Math just flows for me, so as soon as the topic was approached and the steps were stated I could follow and I moved on." Evan almost immediately became a student teacher for the classes he took with Dr. R. and Dr. P. including Algebra and Calculus I. Sal and Trevor were also teaching assistants for certain math or computer science classes. As they progressed through the major, the math classes became more theoretical and participants were eventually required to construct formal mathematical proofs.

> [When] I started getting into classes that dealt more with theory and proving theorems and stuff, that's when it started to get a little more challenging for me. Because applying formulas and computation and stuff like that, that's just like second nature. But to understand where they came from and to prove things yourself, really took more than just calculating on a piece of paper… it really brought you out of the box. (Alexis)

The upper level classes were more discussion-based, which helped when it was time to generate logical mathematical arguments. Evan learned a lot from professors who "always gave you questions that you could literally sit there and debate with them about it… things that you thought were straightforward and easy sometimes definitely weren't very easy."

The participants interpreted the upper level classes differently, depending on their goals after graduation. Sal found the upper level classes and the work to be boring, but he knows CPC has a strong mathematics program. "I think the undergraduate program at CPC teaches you a lot about mathematics. If you go on to graduate school you're going to be ahead of the game." Sal has friends who attended graduate school while he was an undergraduate, and they compared notes. Sal was never interested in applied math, which is why he pursued a master's degree in higher education instead. However, Evan knows from his summer internship and graduate level experience, and also from attending the CAARMs conference that Dr. R's curriculum binders really were

"full of problems to definitely get you to think outside of the box… in a way that you definitely need to as a mathematician."

Trevor never found any of the math to be difficult. Still, he found a connection between what he learned in Set Theory and the computer science industry.

> That was enlightening… what I normally like is knowing the definitions so I could always derive. It provided me with the definition of what functions are and how sets are related to function. So I could formulate better… especially computer science when I'm writing applications, dealing with mathematics or any various other sciences. (Trevor)

The upper level math classes had fewer students, and so it created a community-like or family-like feeling for the participants. According to Alexis, "not everybody is a math major, and some of my classes they were only like maybe five people." Most of the upper lever math classes ran only once a year, and so the participants had to take those classes when they became available. Even so, the college sometimes threatened to cancel due to low enrollment. Luckily, none of the participants encountered any issues with cancelled math classes.

Evan, Sal, and Trevor had trouble with other course requirements, but not because of the content. Sal had a conflict with a Writing professor and so he dropped the class so his grades wouldn't suffer. Trevor took an incomplete in English and he withdrew from History several times before he finally persevered through the course. For both subjects, he simply could not motivate himself to do the work because he found it to be such a hassle. Evan had a similar experience with English. Evan and Trevor are competent writers: Evan has had a published academic paper, and Trevor is working on a personal writing project which he hopes to someday have published.

Summary of Undergraduate Experiences

The pursuit toward the mathematics degree was discrete and personal, but also situated in a distinct and important community of learners and faculty at CPC. Some participants were more independent than others at certain junctures. All four participants experienced challenges with regard to busy schedules, finances, logistics, personal struggles, academics, and/or shifting priorities as they worked toward the degree, and they relied a network of student cohorts and faculty members who helped them academically, personally, and logistically as they navigated the path toward graduation. This is consistent with research suggesting that nontraditional students can be more vulnerable to challenges that might affect their well-being, stress-levels, and persistence (Markle, 2015; Palmer et al., 2010), but educational resilience can be fostered in a nurturing environment (McCreary et al., 2006). As undergraduate students at CPC, the participants worked through demanding upper-level mathematics courses. They accessed faculty support, tutoring and other leadership opportunities, study groups, and peer support systems as well as internships and research opportunities. Access to these support structures was instrumental to these participants' success as mathematics majors at different times and to varying degrees. This is consistent with the body of research about supportive campus environments (Borum & Walker, 2012; Solórzano & Yosso, 2000; Tatum, 2007), mentorship (Guiffrida, 2005; Schwartz, 2012) and their impacts on social and academic integration (Tinto, 1997) and academic identity formation (Bir & Myrick, 2015; Martin, 2000; Perry, 2003). The themes from *Undergraduate Experiences* will be further examined in Chapter 6.

Beliefs About Persistence and Success

All of the graduates participating in this study experienced at least one hardship or hitch that could have interfered with the potential to walk a sound and continuous path toward the mathematics degree. And yet, they persisted. In this section, I present themes that emerged when participants reflected on their personal success and shared their beliefs about persistence and success. These themes, as outlined in *Table 9*, emerged as participants grounded their beliefs in their distinct and personal journeys toward success.

Table 9: Themes that emerged when sharing *Beliefs about Success*

Theme	Evan	Sal	Alexis	Trevor
Commitment		x	x	
Research	x			x
Involvement	x		x	
Willing to work	x	x	x	x
Persistence	x		x	
Internal motivation		x		x

The characteristics and behaviors outlined in *Table 9* were interconnected, and yet they showed up differently for each participant. Concurrent with the personal journey toward the mathematics degree, I organized the first part of this section by participant. Each participant first reflected on his or her beliefs based on personal experiences, but during the conversation they shifted their perspectives outward. Interestingly, all of the graduates from this study now teach in some capacity, and all have remained connected to the Mathematics Department at CPC. With that said, some participants compared their personal beliefs about successful behaviors and characteristics to their observations about the students they encounter, and some reflected on the success and future of CPC and undergraduate programs in general.

Personal Experiences: Reflections and Beliefs

Sal.

> I worked for a lot of years. I've seen what it is. When I left high school, I wasn't ready for college. I worked for 17 years that's how I know what's out there. When I went back to school, I know what I had to do. I know what I wanted. I knew how to get it. Stay focused, follow the plan, and hard work pays off. (Sal)

Sal wanted to quit when he first set out his undergraduate journey at CPC, but he immediately decided to ask for help not only because "I'm not afraid to ask for help if I need it," but mostly because he was committed to the goal because he had set. That and he had already paid for the class. It took Sal a long time to be ready for college, and to set that goal for himself.

Sal believes that not everyone has what it takes to be successful in college. He also believes that college is not the right path for everyone.

> [Not] everybody is college material. Some people just don't get it. They need to be out there working and they're wasting their time here… College is not for everybody. I've always believed that. At first I thought it wasn't for me, when I first- when I left high school, but it *was* for me, I just didn't know it yet. (Sal)

When he first left high school, Sal was not interested in academic pursuits. Once he had gained life experience and decided to return to college, Sal was ready to put in the work and stay focused until he had the degree.

Alexis.

> I think that when you're in college… if you want to get the good grades and you want to gain something, you want to accomplish, that you want to get your degree, you

want to be the best you can be… it becomes your life. But that's just how it has to be for a student. I mean, you can only get out what you put in and if you don't put in enough you're not gonna get anything that you want at all. It takes time and it takes persistence. (Alexis)

Alexis believes that in order to be successful, a student has to be fully committed and willing to put in the effort. For her, that also meant letting go of the deeply engrained desire to do everything independently.

I learned that I need to be a team player and spread the love (laughter) – instead of keeping it for myself. It doesn't benefit- I mean, it might benefit me but in the long run it doesn't because it just becomes too much just for one person. So the more I can work in a team the better it is because you get to delegate responsibilities because it turns out to be a better end product than if I were to do it by myself. (Alexis)

As someone who mostly keeps to herself, it took some time for Alexis to accept the family-like community of faculty and students that awaited her in the Mathematics Department. At some point during her pursuit toward the degree, Alexis began to think about the fact that everyone was there "to accomplish something that is pretty much great," and this personal shift made it easier to open up. Once Alexis made new friends, they formed study groups and together they persisted through the more difficult mathematical content. Success for Alexis was a personal and collective pursuit.

Trevor.

Trevor struggled with motivation and distractions as an undergraduate student, and so his beliefs about success center on these ideas.

> Consistency. I would say from my experiences you have to be consistent if you really want to succeed in the college realm, can't allow things to distract you. Be consistent, achieve your goals, but at the same time… besides that make sure you're doing your outside research. Whatever your field is, also study that alongside your requirements for getting your degree. (Trevor)

Success for Trevor extends beyond earning the degree. What happens afterwards? The degree is a step in the process toward a person's actual goal in life, but college by itself is not enough. Trevor believes that in order to be successful, a student must plan ahead. Attending and passing classes is not enough; a student must find out what is required in the job market and pursue those experiences or certifications simultaneously.

This, in turn, can help with motivation to persist. Trevor believes that anxiety about finances can distract a student and detract from persistence and success. Students worry about, "Is this degree going to actually get me a job that could help me pay off the loans?" Trevor believes that the combination of consistency and outside research will build a student's confidence to remain motivated and stay on track.

Evan.

> Life happens and it takes time. And you just have to have the patience and the perseverance to stick it out. And so doing my undergrad degree there were times like I said during different adversities, you could give up. But you learn how to stick it out. And you learn that there's a bigger picture and I learned how to maneuver through the obstacles. (Evan)

Evan always had patience, but he learned during his undergraduate experiences to see the bigger picture. Evan attributes his success not just to patience and perseverance, but also his willingness to put in the time.

> I was able to see the benefit of just being around… You could be doing fifty million other things that are very important but you sacrificed that time to just be around. And a lot of students just don't do that. They don't sacrifice their time for just being in the places where they could get the help, be in the places where they could get the knowledge, be in the places where they could get the life lessons that they need to move forward. (Evan)

Evan's beliefs about success also center on the lessons he learned from his mentors and teachers, both past and present. Some of these lessons might not have felt meaningful at the time, but he trusted the process.

> I'm a firm believer in sometimes people share things with you that you don't necessarily get, but then when you're actually put in that type of situation or in that circumstance then you finally really get what they were trying to say. So sometimes you just don't get the really big picture. Like, you'll get some of the message… may not understand it, but you just internalize and keep it in, that has a way of now coming up and it's like, 'Oh my gosh that sound like my fifth grade teacher! Oh my gosh, that sound like my dad!' (Evan)

This belief made it easier for Evan to persist on the days when he could not yet see the bigger picture.

> I will say there were some times that I said, 'I want to go home, I'm tired!' Or I've been writing on the board for five hours and you want me to write when I get to class,

> my arms are getting ready to fall off! Like, come on! So there were times when it was tiresome, but I think I just knew, I think I just knew the benefit of it. (Evan)

Shifting the Perspective: Observations and Reflections

The most compelling and surprising theme from this study emerged as participants continued to reflect on the meaning of persistence and success as it pertains to earning the mathematics degree. Each participant indicated that he or she teaches in some capacity at CPC, and each participant shifted the perspective outward toward current students, the mathematics program, the greater community, or some combination of these elements.

As Sal and Alexis shifted the perspective toward the students they teach, both reflected on being ready for college, but not just academically. With regard to students requiring remedial courses, Alexis notes that there must be a "breakdown somewhere" because of the study habits some students exhibit.

> [Not] to blame just one entity because I believe it comes from your parents, yourself, your school, your society, it's all everything in one but something was lacking where there was no push for them to do better or motivation for them to do better because when they come even if, and even as they are in remedial, they're still about- they're just about the phone and being on the phone. And not to say that all of them are like that, but a lot of them are. There has to be some kind of bridging the gap between showing up just to be present and actually showing up to do the work… And I think that the mentality has changed drastically. (Alexis)

While teaching remedial courses at CPC, Sal has also encountered students who appear distracted or unwilling to try, or who attend class only to fall asleep. Sal and Alexis believe that a student must have personal motivation and accountability in order to

be successful. It's not enough to show up for class; a successful student puts in the work. A successful student is brave enough to try and willing to ask for help if he or she doesn't understand.

> I just know you've got to try and put an effort into everything you do. If you don't try. Put it this way: I think you don't fail until you stop trying. So I tell students, 'You might fail a remedial course but that don't mean you're going to fail that, period. You just gotta try again try even harder until you pass this course.' I was talking to one lady she took the remedial course, [Arithmetic], ten times before she passed. She kept saying, 'I just can't get it.' I said, 'Pam, you will get it, just keep trying.' The tenth time she passed. Just this past semester she passed. She was shocked. She cried that she finally passed the course. (Sal)

As a college instructor, Sal has observed that students like Pam, who are committed and willing to work, eventually succeed in their pursuits. As a tutor in the Math Department at CPC, Alexis also sees a difference between the students who come for help and those who don't.

> I don't know what else we can do, or what else we can say to attract more students to come for help, but I don't know, I think we gotta think of some new ways to attract them here. Because the ones that do come and do take advantage of the opportunity, they benefit. They do, they really do. And you can see them progress class to class to class.

Alexis knows she cannot make anyone show up to put in the work or take the help. At its core, success is up to the individual student.

> [At] the end of the day, when you become an adult all your decisions are yours. Nobody else can make the decision for you, so your success is yours, your failure is yours. You gotta own that. (Alexis)

While all four participants believe to some degree that success is a personal pursuit, they also reflected on their observations about remediation, academic preparedness, and how they personally try to impact the success of others. Sal, Alexis, and Evan believe that as teachers, tutors, and mentors, they can help other students persist. Alexis and Sal said this about the students they encounter who require remediation at CPC:

> [A] lot of students that I come in contact with that are coming straight out of high school, they don't know how to read properly, they don't know how to write properly, and a lot of them have to do remedial math and remedial English. (Alexis)

> [Some] of the schools around this area, they're not preparing the students for college material. That's why they're flooded with remedial courses. Remedial English, remedial writing, remedial reading. Right out of high school? That's incredible! I'm amazed. These courses are not intended for the students out of high school. These courses are intended for students who been out of school for 10 or 12 years as a refresher course so they can remember what you do when you are in high school now you are ready to take college-level material. Not students right out of high school. That's how I see it. (Sal)

Sal believes that this trend indicates a broken system. Standardized testing, new teaching approaches, lower expectations, and social promotion were just a few of the factors Sal mentioned. Sal also reflected on the deep disparities between the local neighborhood schools and the schools in the "so-called White neighborhoods," noting

that he doesn't see the same deficiencies in students who attended better schools. Trevor alluded to these disparities as he compared his educational foundation to what he sees, noting that early exposure is key so that students will be prepared for college success.

> [If] a child is not exposed to that they'll enter college lacking the basics, or incapable of, pursuing higher levels. They just follow the schedule and move on from them and at that point most of these students really do not absorb it. They just get enough to pass the class and then forget it. (Trevor)

While the participants acknowledge they cannot singlehandedly address these disparities or reduce the number of students needing remediation at CPC, they do believe in their abilities to help. Sal asserts, "it's not like these kids are stupid. Give 'em credit because they want to do better. They want to go to school." Sal does whatever he can to help his students to retain the course material.

> I tell my students, 'Come to the board and show me what you're doing.' Sometimes they're hesitant, but eventually they come. So I see what they're doing and honest I want them to see it because some of the students might have the same problem they're having so everybody sees it, or where the mistakes are being made… So eventually they get more into it. Stop being a spectator and I say, 'Let's get into the game.' (Sal)

Sal also works to help his students see the faculty as people who are there to help. He wants to convey that, "It's always good to have good rapport with your professors, get to know them. Have them know you. Any problem you go to them, talk to them as a person." Evan also reflected on the relationship between students and faculty, noting that students must devote time toward the pursuit but faculty must be available.

I think students have to understand the benefit of time, putting time in and sometimes just being an apprentice. Being that junior, or whatever and not worrying about when other people say or do because you need it for yourself and I think teachers have that open-door policy where they invite students to come in and learn. A lot of times it's just for some teachers or professors it's just oh come in, let me teach my classes and close the door and I work on what I need to work on and I go home. And there's no impact on students. So the impact on students from professors and the then the students making sure that they make themselves accessible to be there. (Evan)

Evan and Sal bring personal approaches to their roles as mentors at CPC. Evan reflected back to his undergraduate years as he described his approach to advisement and mentorship.

[My] experiences have given me a lot of wisdom… far beyond what people would expect me to know. I guess and learning from that experience to okay, now that I have it, being able to now cultivate it and then also being able to impart it to others. (Evan)

Because he learned patience and perseverance through his undergraduate experiences and from his mentor, Evan strives to build the same qualities in his students. Evan views himself as a role model not only because he came from CPC, but also because he did not encounter very many young, successful Black male mathematics students or mathematicians as an undergraduate student. These factors fuel his personal drive to help others persist.

[A] lot of younger people will kind of have more of a connection with me and they kind of draw to me a little more and they're like 'Oh, how did you do this?' Even

now. 'Oh well how did you do this, you're not 40, you're not 50 – how'd you get here?' And I'm like, 'Look you can do the same thing too. You just have to kind of keep your mind focused on what you want and go after it.' (Evan)

Sal also brings his personal experiences to his conversations with students. He encourages his students to "put their priorities in order" because he sees that some students straight out of high school are so focused on partying. Sal understands this mindset.

When I was 18 I thought the same way, so I can't really get on their case about it. I was at the spot they're in. So I try to give them a little guidance, but sometimes they have to make their own mistakes. Sometimes the school of hard knocks is the best education you can have. You learn from your own mistakes. (Sal)

But still, Sal talks with his students and he tries to help. He believes that if he shares his experiences and offers guidance, some students will hear it.

I've told a lot of students, "I've been where you are already. I know what the world is like. The world will eat you up if you're not prepared for it. You can have good remedial jobs. You might get lucky and get one of those good civil service jobs, but is that what you really want to do with your life?" That's not what I wanted… You're going to find yourself out there, what you want to do with your life, and school is a way to help you get to that goal. Whatever you want. (Sal)

Sal figured out during his undergraduate years that no instructor wants to fail a student, and now he understands first-hand. "I don't want to see students fail. When you pass it makes me look good. (laughter) Yeah, I'm proud of them! That means I'm doing a good job." Alexis also draws personal satisfaction from seeing her students succeed.

As the students she tutors progress through their courses, “They always come back, ‘Help me, help me’… and it’s a good feeling.” Evan too:

> I’ve always helped people in any aspect or avenue that I could. And that stems from family to friends to school to anything, just always just there to help and assist. So in being a teacher I do that, and then when I have students that come back and give me that feedback it makes it all the more rewarding. (Evan)

Trevor works to help his students through his content and curriculum. He believes college should be a place where people build connections and networks, and as an instructor he tries to help his students find more success in life. For his college level Algebra and Trigonometry classes, Trevor plans to infuse small projects that apply to real financial or marketing applications.

> How can you build your financial stability… So as they are exposed to all of these little things they’ll know that when they go out in their daily life they’ll start probably looking at the things they’re purchasing, are these things really essential. And, hopefully, they could use it to better themselves. (Trevor)

Evan talked about the cycle of success at CPC as he envisions it. While the college motto reflects creating one successful student at a time, Evan believes that the math program has to create the atmosphere where more students become successful. A stronger program builds stronger alumni. Evan referred to mentorship, academics, and research opportunities as he verbalized the following.

> On one level, you could say this is only an undergrad program… but then it’s all about when you put the time into developing your students, then you have stronger alumni that can come back and help you develop stronger students, and that cycle just

keeps continuing and then you graduate stronger alumni. And that cycle just keeps going on and on and on. (Evan)

Summary of Beliefs about Persistence and Success

The participants from this study encountered difficult situations during the pursuit toward the mathematics degree. They each believe that success or failure is up to the individual. As they reflected on success, each participant uniquely and distinctly portrayed the idea of commitment, research, involvement, willing to work, persistence, and/or internal motivation.

The most compelling and surprising theme from this study emerged as participants continued to reflect on the meaning of persistence and success as it pertains to earning the mathematics degree. Each participant indicated that he or she teaches in some capacity at CPC, and each participant shifted the perspective outward toward current students, the mathematics program, the greater community, or some combination of these elements. The participants revealed a sense of intimacy, urgency, and hope as they reflected on the students they work with, and the actions they have taken to support these students. They connect curriculum to the students' everyday lives. They try to engage the students with the mathematics by using a collective approach to learning. They give advice. They make themselves available. They offer help. They offer help again. In essence, they *care*.

The participants' instructional practices are consistent with culturally responsive pedagogy (Ladson-Billings, 1995, 2009; Tate, 1995a), and also with the research suggesting that students who require remediation do not benefit from traditional instruction (Asera, 2001; Preston, 2017).

Beyond their instruction and tutoring practices, the participants from this study conveyed a deep and meaningful sense of commitment to the CPC mathematics community. They viewed their positions as role models to future students, and they considered their contributions as advisors and mentors to be meaningful and impactful. While the participants from Ellington and Frederick (2010) were personally driven by the example they felt they set for the Black community (and more specifically, for their home communities) as high achieving mathematics students, the participants from this study seem to be more outwardly driven because they have already graduated. In documenting the stories of Black mathematicians who have earned the PhD, Walker (2011, 2014) found that many of these accomplished scholars teach at HBCUs and/or create partnerships with schools or community centers to foster the mathematics giftedness of elementary and secondary students. The late Dr. R., an accomplished mathematician who helped establish the CPC Mathematics Department and went on to directly impact each participant from this study, potentially could have been featured in Walker's (2014) research.

This was different.

The participants from this study never left, or they went elsewhere to earn a master's degree and they came back to work with the next generation of students at CPC. This finding offers a new interpretation of what Walker (2014) named the "Circle of Responsibility," in which Black mathematicians return to teach undergraduate or graduate studies at HBCUs. It relates to Martin's (2006) notion of educational agency and resistance, in which Black community members become educators in order to change the system. Martin (2006) suggests that by reinvesting in mathematics, Black people

become agents of change because not only are they normalizing the success of people of color, but as educators they might be better equipped to teach people from within their communities.

This just might disrupt the narrative.

Return to Overarching Metaphor

From source to mouth, the Mississippi River stretches a long and arduous 2,230 miles. The pursuit from kindergarten through mathematics degree attainment at CPC was also long and arduous for these participants, and yet rewarding.

The river is laden with idiosyncrasies including variant tides and currents, mud deposits, flood plains, and bayous. So many obstacles that might interfere with the sound and continuous journey from beginning to end. The participants from this study navigated the educational paths toward the mathematics degree in ways that were neither linear nor predictable. They perceived the pursuit as personal and yet influenced by others who helped supply knowledge, tools and connections that made the journey easier (or more difficult) in both tangible and intangible ways.

> It was a big river, below Memphis; banks brimming full, everywhere, and very frequently more than full, the waters pouring out over the land, flooding the woods and fields for miles into the interior; and in places to a depth of fifteen feet; signs all about of men's hard work gone to ruin, and all to be done over again, with straitened means and a weakened courage. A melancholy picture, and a continuous one; hundreds of miles of it. Sometimes the beacon lights stood in water three feet deep, in the edge of dense forests which extended for miles without farm, wood-yard, clearing, or break of any kind; which meant that the keeper of the light must come in a skiff a great distance to discharge his trust – and often in desperate weather. Yet I was told that the work is faithfully performed, in all weathers…
>
> -*Mark Twain, Life on the Mississippi (1903)*

As undergraduates, the participants from this study sometimes felt overwhelmed, or submerged in the process. *Beacon lights* along a river guide the path and help vessels

avoid dangerous obstacles. A person who acts as a *beacon* inspires and encourages others. The participants from this study benefitted from beacons and acted as beacons during the undergraduate journey.

If Walker (2014) names the path to excellence, the graduates from this study continue to line the path as beacons who guide, help, inspire, and encourage. It is reminiscent of the African American proverb *Each one, teach one*. The proverb originated during the times of American slavery when Africans and African Americans were explicitly denied the right to an education. If an enslaved human was taught to read or learned to read, it then became his or her distinct duty to teach somebody else.

Each one, teach one. This was not only a phrase, but a collective movement. It was an act of unity so that as many people as possible could attain the fundamental right to literacy.

Fast forward to our current educational system.

The fundamental right to mathematical literacy, and to mathematical degree attainment. It certainly helps to know and learn from someone who has navigated the river before.

Chapter 5 Summary

This chapter presented an analysis of the findings from this study, which explored the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution. The themes, which explain how family, educational, personal, and community influences and experiences contributed to participants' persistence and success in mathematics at various phases of their educational trajectories, were discussed in three phases: (1) life and

schooling experiences, (2) undergraduate experiences, and (3) beliefs about persistence and success.

Chapter 6: Discussion and Conclusion

This chapter presents a discussion and conclusion for this study, which explored the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution.

I begin with a summary of findings based on the research sub-questions from this study. I then abstract the findings from this interpretive case study into a discussion of larger "lessons learned" about how these participants experienced persistence and success in earning the mathematics degree at an under-resource PBI (Creswell, 2013; Merriam, 1998). Following the discussion, I connect the findings back to the research question anchoring this study, which was: What are the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution?

After I address the primary research question, I conclude this dissertation with implications and limitations of this study and recommendations for further research.

Summary of Findings

Sub-Question 1

- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their life and schooling experiences?

In general, the participants' experiences began in neighborhoods not too far from CPC within tight-knit families who were engaged in their social or spiritual communities.

They had supportive parents who instilled educational values, encouraged their success, and advocated for them at certain times during their elementary and secondary schooling. They attended local schools and choice schools, and they always excelled in math. As they navigated their K-12 schooling years, the participants encountered caring and influential teachers as well as teachers whose actions or words impacted their educational journeys in surprising and sometimes negative ways. They also met teachers who recognized their mathematical abilities, pushed them to excel, and sometimes exposed them to other mathematical opportunities.

Sub-Question 2

- How do Black women and men who have earned their degree in mathematics from an under-resourced PBI describe their undergraduate experiences?

While all of the participants attended and graduated from CPC as mathematics majors, none of them joined the CPC mathematics program directly after high school. Once they enrolled in the mathematics major, the participants joined a distinct community of students and faculty members. As undergraduate students at CPC, the participants accessed faculty support, tutoring and other leadership opportunities, study groups, and peer support systems as well as internships and research opportunities. The participants faced unexpected personal, academic, and logistical challenges throughout the undergraduate pursuit, and so access to these support structures was instrumental to their success at different times and to varying degrees.

Sub-Question 3

- What factors do Black women and men who have earned their degree in mathematics from an under-resourced PBI perceive to be associated with success in earning the mathematics degree?

This sub-question was central to the study because it essentially asks participants to reflect on the significance of their experiences, and to draw meaning from their success in earning the mathematics degree. The participants from this study believe that success or failure is up to the individual, but they also believe in their ability and responsibility to help others succeed. Each participant uniquely and distinctly portrayed the following ideas from an inward perspective and an outward perspective: commitment, research, involvement, willing to work, persistence, and/or internal motivation.

Discussion

To appropriately and thoroughly address the primary purpose of this study, which was to explore the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution, I conducted a further examination of the findings and themes from *Undergraduate Experiences*. In doing so, I abstracted the initial findings and themes into three deeper, overarching themes and created a visual representation of the participants' overall experience with successful attainment of the mathematics degree.

The participants from this study shared certain personal characteristics including a growing enjoyment of mathematics over time, and a success-oriented mindset that enabled them to work through challenges and obstacles along the way. As they encountered unpredictable life events or managed busy schedules and multiple

responsibilities, the participants relied on *People Who Cared* about their personal and academic success. The graduates from this study felt comfortable within the social and academic mathematics community, and it was this *Sense of Belonging* that enabled participants to seek help and capitalize on leadership opportunities. Even so, success was a personal pursuit, and their overall *Personal Agency* characteristics intensified as graduation neared. The overarching themes that emerged from this study were (1) *People Who Cared*, (2) *Sense of Belonging*, and (3) *Personal Agency*.

People Who Cared

The graduates from this study had strong family support systems as they pursued the mathematics degree. Whether it was a supportive spouse who maintained a quiet study environment, extended family who provided childcare, or people who provided verbal support and encouragement, the participants knew their family members cared about their success. This is consistent with findings from Palmer, Davis and Maramba (2010) suggesting that family encouragement, among other factors, contributed to success for Black males who persisted to graduation. Beyond that, the participants inherited the educational values their families had instilled. They knew education was a priority from a young age, and that resonated with each participant throughout the academic journey. Ellington and Fredrick (2010) similarly found that high achieving undergraduate mathematics students attributed their ongoing success, in part, to the fact that their families encouraged them to excel in mathematics from an early age.

Within the CPC community and especially within the Mathematics Department, the participants found an approachable network of faculty members who often maintained open-door policies for the students. They answered math-related questions, offered

academic and non-academic advice, and provided support for students. The participants from this study reported that coming to the Mathematics Department felt like coming home and being with a second family. The faculty members understood who they were both personally and as students, and so they were able to offer personalized advice and guidance if needed and as needed. These interactions are characteristic of supportive and caring faculty members, suggests can contribute to the success of Black students who persist to graduation (Beasley et al., 2016; Palmer et al., 2010; Strayhorn, 2015). Participants from this study reported that there were existed some faculty who were less personable or less approachable, but each participant found someone who they could relate to, and someone who took the time to build a longstanding personal rapport with them. Effective mentors do exactly that: they build relationships with students that extend beyond graduation (Schwartz, 2012).

Scholars have found the importance of mentorship for academic identity formation (Bir & Myrick, 2015), and as a motivator for persistence (Chang et al., 2016) among minorities in STEM degree programs. Studies have also found that effective mentorship can have a transformative effect on the success of underrepresented minorities in STEM degree programs (Kendricks, Nedunuri, & Arment, 2013; Schwartz, 2012). Some participants from this study indicated that one or more formal mentors during their undergraduate pursuits, while others benefitted from what Hernandez, et al. (2017) referred to as an informal mentoring experience.

Mentorship refers to the relationship between a more experienced person and a less experienced individual. In the academic setting, the more experienced individual (the mentor) works to enhance the student's personal development, academic and social

integration toward a profession (Hernandez et al., 2017). During the earlier academic years, an effective mentor assists the student in navigating a new academic culture and its social capital. Schwartz (2012) referred to this as the "ushering" component of mentorship. The findings from this study align with this description of effective and transformative mentorship experiences. Participants reported that their mentors guided them toward internships and research opportunities, and toward successful graduate programs and experiences. Some participants received moral support through personal circumstances or academic challenges from their mentors, as well as advisement and assistance with coursework unrelated to mathematics.

Mentors stayed after hours for personal conversations, and sometimes they came to campus during the weekend to work with students. These mentors took the participants underwing and invited them to correct papers, co-teach classes, and coauthor manuscripts that were eventually published. While these aspects of the mentorship experience can be intensive for both faculty and students (Schwartz, 2012), they are also the most rewarding and transformative for persistence and success in the discipline. The participants appreciated the time and commitment their mentors put into their academic and personal success, and they felt that their mentors truly cared. This aligns with Fries-Britt and Turner's (2002) notion that the most impactful mentors go "beyond the call of duty" for students.

These mentorship experiences also align with the notion of "othermothering," which refers to caring and tending to the needs of other people's children (Kendricks et al., 2013). Guiffrida (2005) developed a framework of othermothering to better understand how African American students perceive the student-faculty relationship on a personal

level as it relates to academic success. This ability and desire to attend to the unique academic, career, and personal issues of each student is key to providing an authentic level of personal support, advisement, and advocacy in a mentorship relationship (Guiffrida, 2005).

Sense of Belonging

The college success, persistence, and retention literature stresses the value of having students academically and socially integrated into the college experience (Tinto, 1997, 2017). Social and academic integration enables students to feel as though they are a part of the classroom or campus community, overcome academic challenges, and take advantage of resources available at the college which in turn increases their overall performance in college (Tinto, 1997). While Tinto's framework does not specifically address African American students, scholars have used ideas from his work on retention and student departure to understand the experiences of high achieving African American college students (Ellington & Frederick, 2010; Fries-Britt, 1998) and to increase retention among underprepared African American students (Slade et al., 2015).

While discussing reasons for students' departure from college, Tinto (1997) argues:

> Voluntary departure appears to be the result more of what goes on after entry into an institution that of what may have occurred beforehand. Though it is obvious that the pre-entry experiences, for instance as measured by intentions and commitments, do affect subsequent departure, research supports the notion argued here that the character of one's integrative experiences after entry is central to the process of voluntary withdrawal (or persistence on the other side of the coin). Of particular importance are those experiences which arise from daily (academic and social) interactions between students and faculty inside and outside the classroom. Other things being equal, the more frequent and rewarding these interactions are seen to be by the student, the more likely the student is to persist – indeed the more likely he or she is to develop socially and intellectually (p. 82).

The above quote speaks to the nature of the undergraduate experiences recounted by the Black mathematics graduates from this study. Their entry into the mathematics degree program at CPC was shaped by faculty members they met in the program. Had it not been for these professors, some may not have even considered mathematics as a possible major.

Peer support and the tutoring program provided an additional link to academic and social integration, which fostered a deeper sense of belonging to the mathematics community. Participants devoted a great deal of time each day within this community and leading or participating in study groups. These peer groups were particularly helpful once the participants took their first upper level, theory-based mathematics courses. These courses required students to generate abstract deductive arguments, and the participants relied on faculty and peers within the mathematics community to help support them through their academic challenges. These findings are consistent with studies on African-American high-achievers (Fries-Britt, 1998), and Treisman's (1992) work that suggests African-American students benefit from peer study groups in mathematics. While Treisman's study focused specifically on students taking Calculus, the findings from this study suggest similar benefits of peer study groups for higher level, more theoretical mathematics courses. Participants' reflections of what occurred in their study groups mirror components advocated by Treisman (1992) including collaborative problem solving and having the support of more advanced students. In addition, it seemed that participants from this study benefitted from these groups because working within study groups allowed them to bounce ideas with peers who helped them clarify,

refine, and extend their mathematical thinking before approaching faculty with deeper questions.

Faculty members or fellow students invited some undergraduate participants to apply for outside programs or research opportunities. Being a part of these programs and projects not only removed a financial barrier that some researchers cite as a barrier to persistence (Brock, 2010; Palmer et al., 2010), but it also gave these graduates access to additional faculty that encouraged, supported, and advised them in their pursuits. In addition, some participants reported being connected to the larger mathematics or STEM community through internships, professional conferences, or lectures. These experiences provided another powerful layer of academic and social integration because participants had access to outside mentors and mathematical role models, which scholars cite as an important and often overlooked contributor to persistence for African American students (Griffith, 2010; Martin, 2000; Walker, 2014). Additionally, through these experiences the participants were able to explore applications of mathematics and STEM in the career world (Strayhorn, 2015).

The mathematics culture seems to promote individual achievement above collaborative effort (Nasir, Rosebery, Warren, & Lee, 2006). However this seems to contradict the approach and philosophy embraced by the mathematics graduates from this study. Scholars note that African American students seem to thrive in classroom environments where they can interact with their peers (Cobb & Hodge, 2002; Lim, 2008), and they seem to value collaborative work (Fries-Britt, 1998). Participants from this study described discussion-based courses in which faculty and students would jointly construct arguments as they engaged in mathematical debate. They also described

collaborative tutoring sessions or study groups, which were situated in the middle of the Mathematics Department. Faculty would often stop by for a few minutes to join the conversation. The general atmosphere was a collective pursuit toward success, where anyone could come and receive help if they wanted it.

Personal Agency

As seen from the findings, these graduates had families who valued education, and parents who were directly and indirectly instrumental in their early educational lives. Their decisions and influences had a tremendous impact on the participants' K-12 educational journeys and success. The participants from this study mostly complied with their families' values and expectations from a young age. Some participants later departed from these values and expectations in favor of personal goals, motivations, or priorities. After a time, each participant decided to enroll at CPC and ultimately pursue the mathematics degree. This was freeing for some participants because they chose to contradict someone else's expectations, or to leave a college or career path they did not enjoy in order to embrace their love for mathematics or mathematics education. This finding is similar to Martin's (2000) findings in his study of successful African American students about agency. He comments:

> Although I refer to a range of dispositional factors and strategies that contributed to their success as important, an important and often neglected component was individual agency. This agency emerged in the contexts of both the community forces and the school forces that students lived with on a daily basis. A particular important finding was the degree to which successful students recognized and responded productively to their surroundings. They did this by engaging in a kind of self-definition by opposition and resistance to what they considered negative influences (p. 28).

Other scholars agree with Martin that an individual's personal agency can affect academic achievement, especially as it connects to disposition and self-efficacy (Pajares & Miller, 1995). The graduates from this study genuinely enjoyed mathematics, and reported positive attitudes about the content and the work involved. Scholars agree that positive attitudes about mathematics impact persistence and achievement (Pajares & Miller, 1995), and this is particularly true for Black students (Varelas, Martin, & Kane, 2012). While some researchers suggest that African American students are discouraged by mathematical challenges (Oakes, 1990), the participants from this study enjoyed working through the more challenging material in their upper level courses, even as some participants did not enjoy working through the theoretical content.

Connected to their positive attitudes toward mathematics was the participants' self-efficacy in mathematics. Getz (2000) indicates that self-efficacious students believe in themselves and their ability to succeed, and Pajares and Miller (1995) note that self-efficacy beliefs influence the choices people make. Most people will participate in tasks or pursuits in which they feel confident and competent, avoiding those in which they do not (Zimmerman & Cleary, 2006).

Merely liking mathematics and working hard were not the only elements in their personal persistence in the discipline. They had a fundamental belief in their ability to succeed in the major, even if and even as the challenge of the mathematics content intensified. The participants who faced initial challenges with proofs and theorems relied on their self-efficacy to overcome those challenges. They also relied on peer study groups and faculty, and as a result they became more competent and confident in their mathematics ability. Bandura (1994) refers to these as mastery experiences. Through

these mastery experiences a student's self-efficacy in mathematics can increase, thus strengthening the motivation to persist.

Their persistence was tested in other ways throughout the pursuit toward the mathematics degree. The participants from this study faced obstacles and challenges with motivation, boring classes, busy schedules, life and family responsibilities, financial hardships, housing situations, family illness or death, and sometimes a staggering combination of some or all of those circumstances. During these times, participants relied primarily on personal determination to push through. They knew they had a goal, and they found a way to move forward. Sometimes that meant balancing multiple priorities, making personal or temporal sacrifices, or taking a leave of absence. Some participants sought the help of mentors or family members. All of the participants from this study reported that they had to persist no matter what. This finding is consistent with the process of resiliency (Kim & Hargrove, 2013). Students who succeed in academic settings despite the presence of adverse conditions are considered to be educationally resilient (Williams & Bryan, 2013). The participants from this study had the tools to successfully overcome these barriers, and to cope with negative, challenging or traumatic experiences as they continued to persist toward the degree (Fergus & Zimmerman, 2005). While the participants expressed that persistence was personal, they also drew a great deal of support from their peers and mentors as they encountered some of these circumstances. This finding supports the notion that resilience can be nurtured in a supportive campus environment (McCreary et al., 2006).

The broad themes that I abstracted from this study were overlapped and interconnected within- and across- participants throughout the undergraduate journey to

success. What began as a personal pursuit soon became collective as the participants were integrated into the social and academic aspects of undergraduate life. During the pursuit, some participants relied more on *people who cared* than others in order to stay the course. All of the participants felt the *sense of community*, but some participants might have persisted nevertheless. And yet, as they neared graduation, all four participants prominently displayed their *personal agency*. Each one became more determined, more focused, or more resolved. Each participant's experience and path toward earning the mathematics degree was discrete and personal, but steadfastly situated within this distinct community of individuals who cared about their success.

Interconnectedness and Individual Characterizations

In order to more appropriately characterize how *people who cared*, *sense of belonging*, and *personal agency* relate to persistence for the participants from this study, I created a diagram, represented in *Figure 1*, to graphically depict the interconnected and overlapping nature of these three broad themes.

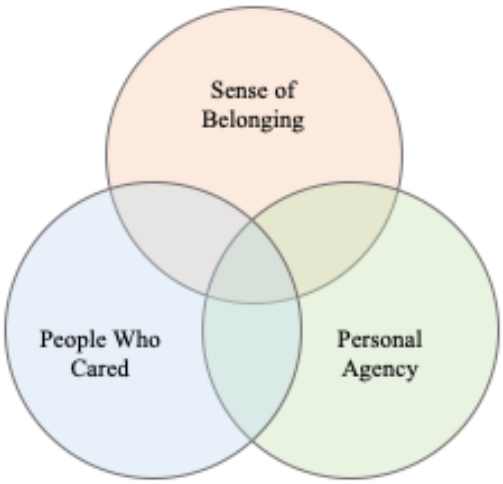

Figure 1: Interconnected nature of overarching themes related to persistence and success for these participants at this under-resourced PBI.

While the diagram is helpful to generically describe and characterize the interconnected nature of the persistence factors that emerged from this study, it is important to recognize that each participant's journey toward the degree was unique. Accordingly, the diagram would take shape differently for each participant. For example, some participants placed more emphasis on specific *people who cared* than how they felt within the CPC community while others placed more emphasis on their *personal agency* factors as they pursued the mathematics degree. It is also important to note that the diagram might look different for the same person from year to year, semester to semester, or even within the same semester depending on personal circumstances. Each of the themes was important for each participant at some point during his or her college experience, and each participant attributed some portion of his or her success to a combination of these broad factors.

Accordingly, I made sample diagrams for each participant. I depicted each circle as more or less saturated, and in some cases I layered the circles in a certain order from front to back, depending on how a participant portrayed or emphasized each theme during a particular circumstance, semester, or year. The following examples represent expressions of the themes as uniquely experienced by each participant at certain junctures during the undergraduate pursuit toward the mathematics degree.

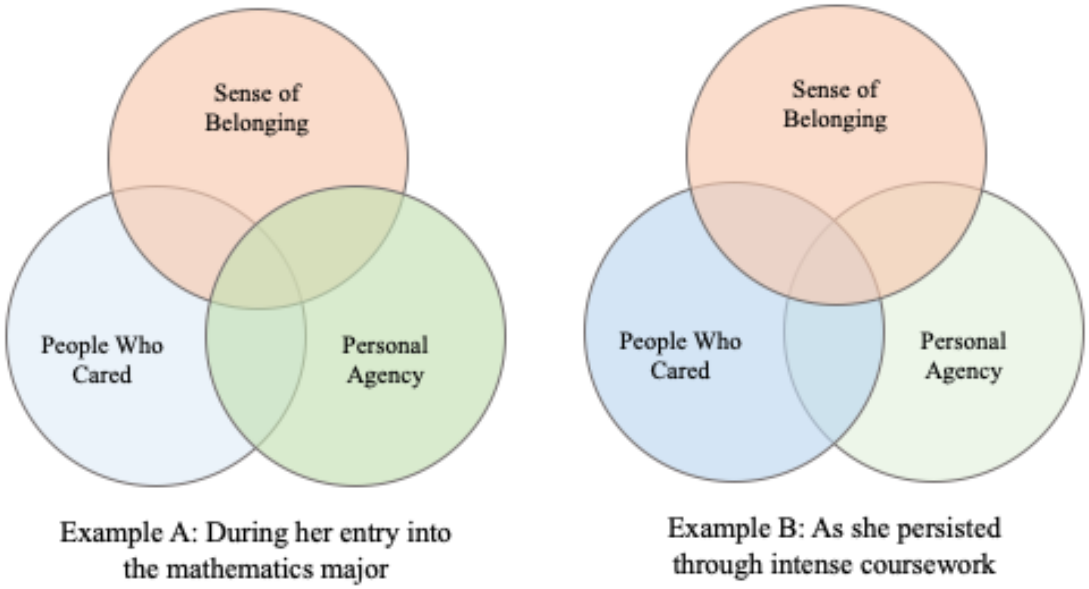

Figure 2: Characterization of overarching themes for Alexis at two points during her pursuit toward the mathematics degree

Once Alexis joined the mathematics program, her integration into the community was important and transformative. Thus, *sense of belonging* was a poignant theme for Alexis throughout her pursuit toward the degree. Alexis's entry into the mathematics major began with an invitation, but really it was a personal decision as depicted in Example A of *Figure 2*. Alexis always knew she loved math, but until that moment she had majored in disciplines that others would have expected. However, social work and education did not interest her. *Personal agency* showed up for Alexis as a form of self-definition when she changed her major to mathematics. Example B represents the themes that emerged more strongly for Alexis after Calculus II, once she was enrolled in the more theoretical courses. She relied more on study groups and the collective pursuit toward success. Alexis also sought the help of faculty members, any of whom she could approach at any time with questions. It was this community of *people who cared* that helped Alexis persist through the intense coursework.

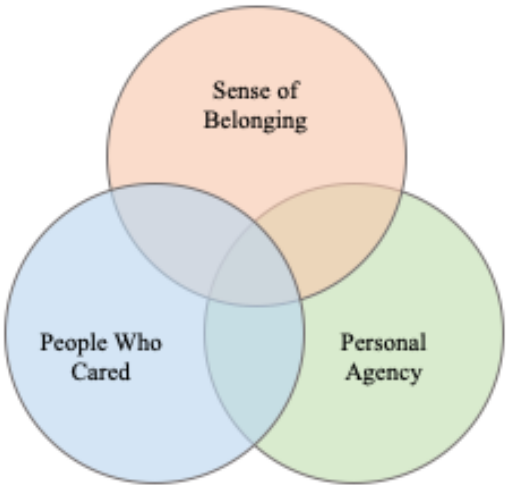

Figure 3: Characterization of overarching themes for Evan during his entry into the mathematics major

When Evan changed his major from accounting to mathematics, all three broad factors emerged with equal significance, and so each of the three themes is depicted with equal saturation in *Figure 3*. Instead, I overlapped the circles according to the order in which these factors emerged. Dr. R first approached and pursued Evan to join the mathematics program as a *person who cared* about his integration into the academic community. Evan began to help others in his classes and within the Mathematics Department, and once he felt that *sense of belonging* he realized that accounting was no longer a passion for him. After a semester, Evan changed his major to mathematics, thus changing his personal and educational trajectory. *Personal agency* is depicted as the final sequential layer for Evan's entry into the mathematics major.

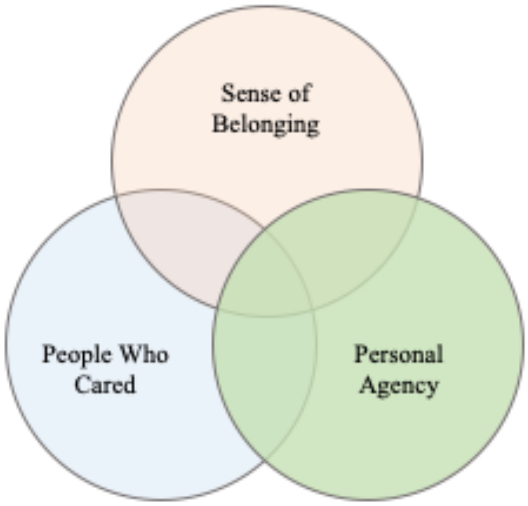

Figure 4: Characterization of overarching themes for Sal during most of his undergraduate pursuit toward the mathematics degree

Personal agency was the most resonant broad factor for Sal throughout his undergraduate pursuit at CPC, as depicted in *Figure 4*. He enrolled in the mathematics degree program with a personal goal and a plan, and he relied on his self-efficacy for seven years as he followed the plan. The other broad themes emerged for Sal during certain situations or circumstances. For example, Sal encountered *people who cared* during informal mentoring sessions as professors guided him toward successful graduate pursuits, or more poignantly during his first mathematics course, when Sal was ready to quit the program altogether and the professor provided personal academic help to ensure his success.

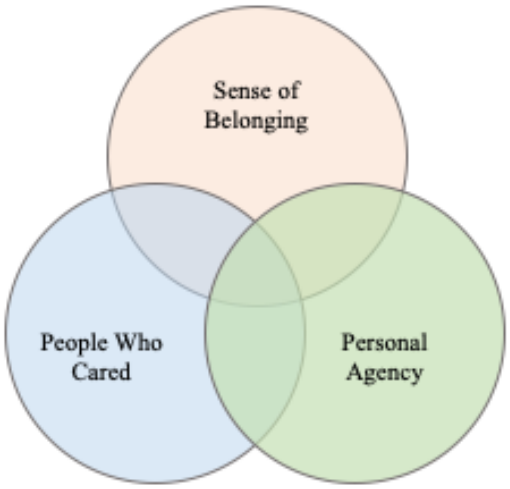

Figure 5: Characterization of overarching themes for Trevor after he resolved to finish the degree

After Trevor took a semester off, he returned to finish the degree. Once he recommitted himself to his studies, Trevor's *personal agency* factors resonated more poignantly than they had since his freshman year, as represented in *Figure 5*. Trevor dedicated his time and energy toward academic matters while *people who cared* about his success including peers and mentors helped him stay on track with paperwork and encouraged him to think about his post-graduation plans.

Each participant's journey toward the mathematics degree was unique. From year to year, semester to semester, or day to day, the diagrams represented in *Figures 2-5* would have shifted for each participant, as if the circles were floating. Additionally, it is important to appreciate that these diagrams reduce the participants' very personalized and distinct experiences into an abstract representation. While almost counterintuitive to the purposes of this study, which documented their stories, experiences, and perceptions, I chose to abstract these participants' experiences into a collective case so I could

effectively shift the perspective once again and appropriately address the study's research question.

Connection to Primary Research Question

The purpose of this study was to explore the challenges and opportunities associated with building and sustaining a successful mathematics degree program committed to access and excellence at an under-resourced PBI. As experts of their own realities, four participants shared their experiences about life history, the college experience, and reflections on their experiences as they relate to persistence and success with the mathematics degree. The following section restates the primary research question anchoring this study, unpacks the components of the question, and then connects the findings from this study to the research question.

Research Question

- What are the challenges and opportunities associated with building and sustaining a successful mathematics degree program at an under-resourced Predominantly Black Institution?

From an institutional perspective, a "successful" mathematics degree program is one that recruits, retains, and graduates a substantial proportion of its students. This question has several layers. To "build" a successful mathematics degree program, a PBI must consider elements including but not limited to facilities, resources, programming, curriculum, faculty, and student supports. To "sustain" this mathematics degree program, the PBI must consider who benefits from these elements and to what degree, as well as the ongoing availability of financial and temporal resources, and human capital. There are so many moving parts. Findings from this study addressed some but not all of the

aforementioned considerations. The findings and themes from this study indicate the interconnectedness of the challenges and opportunities associated with this endeavor, and how these challenges and opportunities relate to the many tiers of recruitment and retention.

Challenges and Opportunities Associated with Access

The Mathematics Department at CPC states a commitment to access and excellence at the core of its mission. Embedded in the word "access" is the challenge associated with the presence of students who arrive underprepared for college level mathematics coursework. Every student who attends college must take and pass college-level mathematics courses in order to satisfy the core degree requirements, no matter the field of study. Community colleges, colleges with open-enrollment policies, and other under-resourced PBIs have higher rates of students who test into developmental coursework, which presents a barrier to persistence and retention. These classes cost students money and yet they do not count toward the degree. High failure rates contribute toward attrition. However, this challenge presents an opportunity for under-resourced institutions such as CPC.

Integrated with the mathematics program at CPC is a Tutoring Program which is both operated and sustained by current and former students. The Tutoring Program is located centrally within the Mathematics Department and is open to anyone who asks for help. The central location implies that the Tutoring Program is just a natural extension of the Mathematics Department. Round tables and movable white boards are set up in a nondescript open space, which sits adjacent to most of the mathematics faculty offices. On any given day, a full range of mathematical conversations echoes through the

department. The Tutoring Program fosters study groups, and in doing so it builds a sense of community among students who choose to participate or benefit. It also creates the opportunity for leadership roles among the tutors, and it promotes stronger relationships between students and mathematics faculty members. Through the process of tutoring, students deepen their understanding of mathematical content because they must continuously explain and demonstrate the concepts to other students. All of these elements can have a deep and natural effect on retention for both tutors and students who receive help from tutoring, simply due to the ways they impact academic success and sense of a welcoming campus climate.

The Tutoring Program at CPC is funded in part by a Minority Science and Engineering Improvement Program (MSEIP) federal grant, which expires after four years. This presents a challenge to sustainability. The ongoing success of the program will likely determine whether the department can secure further financial support. The Tutoring Program is also sustained through recruitment. Faculty members invite all mathematics majors to become tutors, and during class the same professors invite their math students to come to the tutoring department for help. This presents a challenge because not every student shows up. Some students are not prepared for the personal accountability associated with college course-taking. These students appear to be distracted or unwilling to put forth the effort, and according to the participants from this study they do not often ask for help or take advantage of tutoring. However, this cycle can slowly be disrupted over time with institutional commitment.

As a community college and an open-enrollment institution, CPC draws a strong base of students who live nearby and attended the neighborhood schools. Some of the

mathematics tutors are no longer students at CPC, but recent graduates. They still live in the neighborhood and feel connected to the CPC Mathematics Department, and so these tutors either returned to CPC after attending graduate school or never fully left the community. Their stories and experiences are similar to those of current undergraduate students, and their examples can provide a different level of insight and perspective in order to help others persist through introductory mathematics coursework. This, in turn, can affect overall retention. This commitment from alumni also presents a unique opportunity to sustain a mathematics degree program and begin to direct the program's energies toward the notion of *excellence*.

The fact that mathematics degree holders from CPC have returned to work in the Mathematics Department as both tutors and instructors not only indicates a deeper opportunity for retention, but also an opportunity for recruitment that extends beyond graduation. By talking to undergraduate students about teaching opportunities after the mathematics degree, an under-resourced PBI can promote a sense of relevance and purpose which might affect their aspirations beyond the undergraduate degree. This concurrently impacts persistence toward the degree and a sense of belonging which might affect retention in that particular degree program. At the same time, by recruiting and hiring alumni as tutors, adjunct faculty, or full-time professors, an institution effectually demonstrates its commitment to current students.

In order to build and sustain a stronger degree program, the program must have students. The Mathematics Department at CPC is small, and it does not directly enroll many students. Therefore, recruitment is important. Three participants from this study were directly recruited into the mathematics major because a specific faculty member

took the initiative or demonstrated a personal interest. One participant was not yet taking Calculus I, which is the starting point for the mathematics major. Even so, the faculty member saw his potential and pursued him until he joined the Mathematics Department. This demonstrates a creative but important application of the commitment to "access" at this under-resourced PBI. The mathematics faculty members sought to find and recruit potential students, and to build relationships with those students from the outset.

Recruitment is not enough; a deeper and ongoing challenge is retention within the mathematics major. Findings from this study support the notion that faculty who care can have a transformative effect on student retention and persistence. This underscores the benefit of having faculty who are fully dedicated to the success of the students, and who are willing to help students in any way possible.

Related to committed faculty members is the presence of strong and individualized mentorship. Students who attend community colleges, open-enrollment colleges, and under-resourced PBIs and Minority Serving Institutions can be more vulnerable to logistical or personal circumstances that might interfere with persistence. By connecting each student early with the right mentor – one who will build a lasting, meaningful relationship with the student – a Mathematics Department can individually affect retention within the program and help students along the path toward graduation. Mentorship notwithstanding, advisement is collective. For students with busy schedules or personal responsibilities that extend beyond the college experience, availability is key. Findings from this study suggest that math faculty at an under-resourced PBI have the opportunity to affect retention just by being available to help students, regardless of whether they are on a professor's class roster. The openness and availability to talk with

and help students contributed to a sense of comfort and belonging for graduates from this study.

Challenges and Opportunities Associated with Excellence

Again, the Mathematics Department at CPC is committed to access and excellence. The word "excellence" implies rigorous and competitive academic programming so that students will graduate fully prepared for a master's program or their chosen career field. This presents logistical challenges to an under-resourced PBI such as CPC. While the School of Science and Technology enrolls about 40% of the students, and every student who attends CPC must take mathematics coursework, the overwhelming majority of students at CPC stop before or at Calculus I. Still, the relative few who persist through the mathematics major need and deserve high quality upper-level classes, and they depend on the availability of these classes in order to persist and graduate. Due to lower availability of students for the upper-level mathematics classes, CPC offers these courses either annually or biennially. Yet because of funding and enrollment policies, the classes might be cancelled due to low enrollment. This directly affects students with specific course requirements, and thus presents an inherent challenge to retention and graduation.

At CPC, one of the professors would, at times, teach the upper level courses without compensation. This is not a viable option, nor should it be an expectation but it demonstrates not only his personal dedication to student success, but also the lack of other options. It also underscores the importance of recruiting enough students into the major and the opportunities to support each student through the major so this specific logistical challenge might someday become obsolete.

Concurrent with the commitment to "excellence," findings from this study reveal opportunities to continuously build a stronger, more attractive mathematics degree program. When Evan attended the CAARMs conference with Dr. P., it was Dr. R. who sent both of them. Part of building a competitive academic program is ensuring that the department faculty understand what is happening in the field, so they can bring these ideas and innovations back to the department. Dr. R. was already an accomplished and connected mathematician, but he needed to build the expertise of his faculty members. Evan was already an alumnus, but he had remained connected to the Mathematics Department despite the fact that he was attending graduate school elsewhere. When he returned to CPC, he brought back ideas from other universities that he had encountered through internships and research opportunities. This indicates that the opportunity to sustain a successful mathematics degree program exists, in part, through the alumni.

The alumni from the mathematics program at CPC remain connected with one another. Participants from this study talked about former classmates who went on to graduate school and are now teaching at CPC or other colleges. Incidentally, "C." who appears in Evan's and Trevor's counternarratives as a classmate, is the same person as "Professor F.," the faculty member who first welcomed me to the Mathematics Department. We used her office for Sal's second interview, and that is where he showed me the photograph of Dr. R., which is prominently displayed on a bulletin board. Participants also talked about former classmates who pursued applied math fields or secondary education. This presents a deep opportunity to invite other graduates to return as guest lecturers, and to bring new and innovative ideas from the field to help keep the curriculum and resources relevant. In addition, these alumni could help connect current

students to research and internship opportunities. This, in turn, presents another opportunity to retain students because it shows them the span of career fields a mathematics degree would prepare them to pursue.

These challenges and opportunities associated with building and sustaining a successful mathematics degree program emerged from the experiences and reflections shared with me by four participants who graduated with a mathematics degree from a specific under-resourced PBI. Their stories demonstrated the deeply interconnected nature of these challenges and opportunities as they relate to access and excellence. An under-resourced PBI or Minority Serving Institution such as PBI must structure its program in a way that reflects the reality of the mathematics narrative. The task of achievement is serious, but surmountable. Success tomorrow depends on what intentionally happens today. In essence, a program that wants to move forward must find creative ways to leverage the resources it has (i.e. the students, faculty, and alumni) to build the capacities of the next generation of students.

Implications of Findings

The first implication that presented itself through this study is also an opportunity that relates to access and excellence. It exists in the fact that CPC is situated in an impacted neighborhood and community, and yet so many current students and alumni reside locally. Participants spoke at length about personal accountability, work ethic, and the degree of academic underpreparation that emerges from this community. Because alumni remain connected to the college and community, and because so many current students emerged from the community, this presents an opportunity for an under-resourced PBI such as CPC to connect with one or more neighborhood centers or schools through a

partnership or outreach program. A similar program exists already between the CPC Mathematics Department and a local middle school, but it did not emerge through the findings of this study. I only know about it because I conducted a *CPC Community Outreach* study in 2014. (Incidentally, a participant from the *Telling Our Stories* study alluded to the *Outreach* program during our interviews. He had participated in both studies, and after we concluded the interview he mentioned that he did not want to repeat information he had already shared). Other Minority Serving Institutions and their communities might benefit from establishing similar programs or partnerships, intended to build the mathematical literacy of secondary students who might someday enroll at the college.

The remaining implications that presented themselves through this study relate to other aspects of elementary, secondary, and post-secondary practice.

Educators who work with underrepresented minorities must seek to recognize and verbalize mathematical potential as it emerges, and to expose these students to rich mathematical experiences and opportunities. The findings from this study underscore the importance of recognition and encouragement from an early age. It goes without saying that teachers must maintain high expectations and they must provide meaningful educational experiences for these students. In addition, findings from this study suggest that educators should find opportunities to inform parents about important and understated ways they can support, encourage, and advocate for their children throughout their schooling years. Too often the master narrative tells us that parents must read with their children, they must help with homework, and they must show up for every school event. However, a positive family influence can be as simple as instilling success-

oriented values, believing in their children's academic abilities, or engaging their children in social or spiritual networks that extend beyond local neighborhood or school communities.

Secondary educators should encourage all students to take advanced mathematics courses, regardless of whether these students plan to attend college, or to pursue a STEM-related degree or profession. Findings from this study suggest that despite the fact that some students graduate from high school without the intent or desire to pursue a college education, these same students might change their minds years later. A strong secondary mathematical foundation can only help students who might otherwise enter college even more underprepared for college-level course work.

Colleges that serve a substantial proportion of students who test into readiness math courses should look closely at how they structure these courses, and at how they build their support systems for these students. Findings from this study support previous studies suggesting that academically underprepared students, who were underserved by traditional high school structures, should not receive the more of the same when they enter college. Instead, these students require a different and more personal approach to learning. One suggestion that emerged from this study was to integrate structures for study groups or cooperative learning groups into the course instruction. A second suggestion that emerged from this study was to recruit current students to act as tutors and informal mentors for rising math students. Students who enter college having been "pushed through" their high school courses without being held accountable might benefit from being introduced more authentically into what it takes to be a student.

Findings from this study also point toward the challenges students face when they transition from applied, procedure-driven math courses (where they apply algorithms and formulas) to theoretical courses where they construct mathematical proofs. High school and college instructors might consider how they structure their entry level courses so students are supported in the thinking required for the upper level mathematics courses. This might help with the transition toward understanding theorems and eventually writing formal mathematical proofs. Even elementary mathematics teachers might consider how they incorporate language and critical thinking into their instruction. While students will not encounter their first theorem until high school (for example, the *Isosceles Triangle Theorem,* which states that a triangle with two equal sides always has two equal angles; the inverse is also true), upper elementary teachers might integrate "always, sometimes, never" or "if/then" language structures into their discussions so that young students are provided the opportunity to engage in mathematical debates.

Finally, findings from this study suggest that students who attend Predominantly Black Institutions or Minority Serving Institutions similar to this research site need ongoing support throughout the P-20 experience. The barriers they encounter do not cease to exist simply because they become college students, or because they are highly capable of completing the academic coursework. While the path toward graduation seems clear, anything at any time can interfere with the sound and continuous pursuit. These institutions who care about helping students along the path to success would benefit from understanding how to ensure that academic and social support systems are in place just in case students encounter temporal, familial, financial, logistical, academic, or any other expected or unexpected obstacles along the way. For some students, the simple

presence of a caring individual to express a personal interest in their successes and struggles can make all the difference between staying and leaving.

Limitations and Other Research Considerations

The first limitation to this study is inherent nature of qualitative research, and in the purposes of case study research. A case study is a study of *this* case or *these* cases, not all cases (Merriam, 1998). The findings, by design, are transferable to similar populations or groups, but not generalizable to all post-secondary institutions, mathematics departments, or graduates with the mathematics degree.

The research site was a regional, community-based PBI with a non-selective, open admissions policy. While there are about four dozen identified PBIs in the United States (U.S. Department of Education, 2016b, 2017)**,** not all fit the remaining descriptors associated with the study site. In addition, many of the students who attend CPC are nontraditional students. The majority of nontraditional students in the United States who have more than one descriptor associated with being a nontraditional student attend community colleges, for-profit colleges, or online colleges (Radford et al., 2015). These students also represent a strong proportion of students who enroll in 2-year degree programs. Thus, the participants in this study might not represent a significant portion of the general population, of the population of students who attend regional colleges, or even of the population of students who attend PBIs. Nevertheless, the participants from this study emerge from a program that enrolls primarily first generation, minority students who are academically underprepared. Their testimony shares a piece of the story that needs and deserves to be told.

Another limitation to this study is that the participants represent only successful graduates of an undergraduate mathematics degree program. The study did not include the perspectives of the majority of the student population at CPC, or at community colleges in general: those who attempted a STEM degree program and then left the major or dropped out entirely. Their reasons for attrition might lend a different and equally important perspective to the factors associated with persistence and success.

In addition, this study included a small number of participants. However, these participants represent roughly one-eighth of the 32 Black and African American students who were awarded mathematics degrees at the research site from 2000-2015. On a related note, this study only included graduates who entered the mathematics program ready to take college-level mathematics courses. Even so, three of the four participants began in courses below Calculus I, the traditional starting point for a mathematics major. This provides important information, but it also might represent a missing link because a substantial proportion of students who enroll at colleges similar to CPC are not academically prepared for college-level mathematics.

A final limitation to the study is the researcher's positionality. As a White woman interviewing Black and African American participants, I cannot claim to understand the experience of living as a minority in the United States, and in particular the experiences associated with navigating the highly racialized American education system. This presents challenges to both the interviewing process and data analysis. As a community outsider who does not share their social, racial, or mathematical background, I approached this study with humility and a deep level of respect for Dr. Phillips, the math department, and their mission. I believe my strong working relationship with Dr.

Phillips, an already trusted member of their community, enhanced the degree of rapport I was able to build with the participants for this study. It was my privilege to spend time in their community, and to hear their stories first hand.

Recommendations for Further Research

This study documented the stories of 4 graduates of an undergraduate mathematics degree program at an under-resourced Predominantly Black Institution, and used those narratives to explore the challenges and opportunities associated with creating and sustaining a successful mathematics degree program committed to access and excellence. In doing so, it examined the factors associated with persistence toward the mathematics degree. The findings provide perspective about the unique challenges these institutions face due to the impacted communities they serve, but also the transformative potential that can emerge from building a program and community from within. The findings have implications for a variety of aspects of educational practice, and offer a basis to build future investigations for research.

To be considered for participation in this study, potential participants had to have graduated from the mathematics degree program between 2005-2015. Of the 41 possible graduates, 32 were Black. I interviewed 8 participants and ultimately selected the 4 participants who emerged from the American school system for analysis in this study. However, international students comprise an essential part of the mathematics community and the Black mathematics community at this and other PBIs and Minority Serving Institutions. One recommendation for future research is to explore persistence factors from the perspective of international students.

Another recommendation for future research is to investigate perceptions of students who left college and then returned years later to pursue the degree. What made them leave? What prompted the decision to return and then persist? These students and graduates have the unique ability to glance back at what happened and take hold of the present, and to articulate the difference. Interested researchers and scholars can explore this phenomenon, and share findings with policymakers and institutions who care about improving conditions for similar students.

My third recommendation is to conduct future research with students who started in readiness or remediation coursework and then persisted to earn a degree, regardless of discipline. Their counternarratives would tell an important piece of the story. In addition, their perspectives would provide the opportunity to better understand how to help underprepared students integrate into the social and academic community.

Another set of recommendations that emerged from this study is to build on the study's findings around the graduates' unique commitment to remain connected to their undergraduate community. Does this phenomenon exist at other PBIs, Minority Serving Institutions, or community colleges? Can it be replicated? What are the potential long-term effects of this cycle of recruitment and retention? Interested scholars might initiate research around this circle of commitment, study the pattern of graduates returning to teach mathematics at their undergraduate institutions, and develop a theoretical framework.

A similar recommendation that emerged from this study has to do with legacies, influences, and Black mathematicians who dedicate their personal and academic careers to building and bridging mathematics communities for those living in some of the most

oppressed and socially impacted areas. How do accomplished mathematicians who were educated elsewhere land at small, under-resourced Minority Serving Institutions? What are their stories, and what are their visions? The story is documented, but in segments. Dr. R.'s story is not yet documented. Dr. P.'s story is not yet documented. These narrative studies are necessary and needed.

Summary and Conclusion

The purpose of this study was to explore the challenges and opportunities associated with building and sustaining a mathematics degree program committed to access and excellence at an under-resourced Predominantly Black Institution. This study also documented the stories and experiences of four graduates from an under-resourced Predominantly Black Institution by means of in-depth, phenomenological interviews.

This study ventured beyond and beneath statistics and educational outcomes, and found, through the human dimension of the Black mathematics experience at one particular PBI, that the challenges arise from the system and the opportunities emerge from the people. Their stories cannot be quantified. This story cannot be overlooked.

I also work with a segment of the population whose celebrations and successes too often go unrecognized. Visitors to my school, which just two years ago was under the threat of closure due to low academic outcomes, often express surprise when they encounter our vibrant community of learners.

As educators, allies, and people who care, we must teach. More importantly, we must listen to their stories. We must be willing to find exemplary practice and normalize their success because these communities, children, and undergraduate students are fully capable of excellence.

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Appendix A: Telling Our Stories Recruitment Script

(author credit: Dr. Alex Phillips)

You are invited to participate in a research study that intends to document stories of the xxxxxx xxxxxx College mathematics major student experience. We will explore your own personal history and its links to that experience, your reflections on that experience, and your perceptions of the specific personal experiences that led you toward becoming a mathematics major, and later a mathematician or a mathematics educator. Your participation is sought in order to better understand, from the students perspective, the challenges and the opportunities inherent in successfully recruiting, retaining and graduating students from a mathematics program, committed to access and excellence, at an under-resourced, Predominantly Black Institution (PBI).

The study will be conducted and supervised by myself (Dr. xxxx xxxxxxxx, University of Denver) and my Graduate Assistant, Ms. Lauren McKittrick (PhD student, Morgridge College of Education), is assisting me in this process. From this study, we hope to learn ways to refine and amplify undergraduate mathematics program elements to better facilitate student recruitment, retention and graduation. Participation would involve three to five hours of your time, split into three 60-90 minute interviews, which will be conducted at xxxxxx xxxxxx College. Participation will involve responding to questions focused on life history and your undergraduate and professional experiences.

Appendix B: Interview Protocols

Below each question are possible probes, dependent upon participant responses to the initial question.

First Interview

Thank you for meeting today for the *Telling Our Stories* study. Today's interview consists of questions concerning your life and schooling experiences up until the point you arrived at [---] College.

1. Where did you grow up?
   Describe some of your experiences growing up in _____ (and _____).
   Describe some of your experiences with your family, your neighborhood, your larger community.
2. What were your early schooling experiences like?
   Please describe some of your academic experiences in elementary school.
   Please describe some of your social experiences in elementary school.
   What was your family's involvement in your early schooling experiences?
   Who were some of your influences during your early schooling years? Why were they influential to you?
3. What were your schooling experiences like during your early teenage years?
   Please share a story from those years that resonates with you.
   Describe your school community during those years.
   Describe your neighborhood or social community during those years.
   What experiences from outside of your school community resonate with you as an adult?
4. What were your schooling experiences like during your high school years?
   Please share a story from those years that resonates with you.
   Describe your school community during those years.
   Describe your neighborhood or social community during those years.
   What experiences from outside of your school community resonate with you as an adult?

Who were some of your influences during your teenage and high school years? Why were they influential to you?

5. What experiences from your schooling resonate with you the most as an adult? In what ways do they resonate with you?
6. What experiences from your family resonate with you the most as an adult? In what ways do they resonate with you?
7. What experiences from your community resonate with you the most as an adult? In what ways do they resonate with you?
8. What else would you like to share about your experiences during your childhood and schooling years?
9. How did you come to be a student at [---] College?

   How did you come to be a mathematics major at [---] College?

Second Interview

Thank you for meeting with me again. Today I will ask you some questions about your experiences during your time in college as a mathematics major.

1. Summarize/discuss past interview to verify accuracy and/or expand on a particular point. During our previous interview you shared___. Will you say more about ____?
2. Please tell me about your transition into undergraduate education.

   Did you enroll immediately after high school? What was that experience like?

   (or) What were your experiences between high school and college?

   How did you integrate into the undergraduate experience?

   What was it like for you socially? Emotionally? Academically?

   What mathematics courses did you take initially, and what were those experiences like for you?

   Describe your life outside of college.

   Where did you live, work, what roles or responsibilities did you have outside of college?

   What was your personal balance between school and other life experiences at the time?
3. How were your relationships with others at your undergraduate institution?

   Your relationships with other students? With mentors? With faculty? With the wider community? With the mathematics content?
4. What were some of your personal experiences during your time as an undergraduate student?

   Your family experiences, financial experiences, temporal logistics?
5. Please reconstruct a day from your experiences as a student – from morning to evening.

   Would you consider this a typical day? Why or why not?

   What was a typical week like for you as a student?

   What was a typical semester like for you as a student?
6. Describe your path toward graduation as a mathematics major.

What were some successes you felt along the way?

What were some obstacles you felt along the way?

7. Describe your transition after graduation toward your professional pursuits.
8. Was there ever a time that you doubted yourself during or after college? What was that like for you?
9. What else would you like to share about your undergraduate experiences?

Third Interview

Thank you for meeting with me for a third interview. Today we will go deeper into some of the experiences you shared during the first two interviews. We will talk about the significance of events, roles, and responsibilities during your path toward graduation and professional pursuits.

1. Summarize/discuss past interview to verify accuracy and/or expand on a particular point. During our previous interview you shared___. Will you say more about ____?
2. Which of the stories that you shared from your childhood schooling experiences feel most significant to you? In what ways?
3. What are your perceptions about childhood schooling experiences as they connect with college preparation?

    What were your key experiences as related with those perceptions?

    What do those experiences mean to you as you reflect on them?
4. What are your perceptions about high school experiences as they connect with college preparation?

What were your key experiences as related with those perceptions?

    What do those experiences mean to you as you reflect on them?

5. What are your perceptions about life experiences as they connect with college integration?

What were your key experiences as related with those perceptions?

    What do those experiences mean to you as you reflect on them?

6. Which of the stories that you shared from your undergraduate experiences feel most significant to you? In what ways?
7. What are your perceptions about undergraduate experiences as they connect with retention and graduation?

    What were your key experiences as related with those perceptions?

    What do those experiences mean to you as you reflect on them?
8. What are your perceptions about undergraduate experiences as they connect with professional success?

What were your key experiences as related with those perceptions?

What do those experiences mean to you as you reflect on them?

9. What else would you like to share about how your lived experiences as they relate to your successes and obstacles as an undergraduate student? As a professional ____?
10. Please reflect back on the things you have shared during these interviews. What resonates the most with you? As we listen to these recordings and make sense of these conversations, what parts of your story should we definitely include in our analyses?

Appendix C: Informed Consent Letter

University of Denver
Information Sheet for Exempt Research

TITLE: Telling our Stories: Students of Color Share their Careers in Mathematics and Education to Inspire Others
Principal Investigator:
Protocol #:
Exempt Date: 06/1/2015

You are being asked to be in a research study. This form provides you with information about the study. Please read the information below and ask questions about anything you don't understand before deciding whether or not to take part.

You are invited to participate in a research study that intends to document stories and experiences of students who majored in mathematics at from 2000-2015. We will explore your own history and its links to that experience, your reflections on that experience, and your perceptions of the specific personal experiences that led you toward becoming a mathematics major, and later a mathematician or a mathematics educator. Your participation is sought in order to better understand, from the students perspective, the challenges and the opportunities inherent in successfully recruiting, retaining and graduating students from a mathematics program, committed to access and excellence, at an under-resourced, Predominantly Black Institution (PBI).

If you agree to be part of the research study, you will be asked to participate in three 60-90 minute interviews. The interviews will consist of questions focused on your life history and your undergraduate and professional experiences.

Potential risks and discomforts may include the loss of time due to the lengthy interviews or mental fatigue due to recalling and reconstructing life experiences.

By doing this research we hope to learn about ways to refine and amplify undergraduate mathematics program elements to better facilitate student recruitment, retention and graduation.

You will receive a $50 gift card in exchange for your participation in this study.

This study is funded in part by the Faculty Research Fund at the University of Denver.

Participating in this study is completely voluntary. Even if you decide to participate now, you may change your mind and stop at any time. You may choose not to answer an interview question, or to discontinue the interview for any reason.

If you have questions about this research study, you may contact Dr. at the Morgridge College of Education, University of Denver at , or email @du.edu.

If you have any concerns or complaints about how you were treated during research participation, you may contact the Chair of the Institutional Review Board for the Protection of Human Subjects, at 303-871-4015 or by emailing IRBChair@du.edu, or you may contact the Office for Research Compliance by emailing IRBAdmin@du.edu, calling 303-871-4050 or write to the University of Denver, Office of Research and Sponsored Programs, 2199 S. University Blvd., Denver, CO 80208-2121.

The University of Denver Institutional Review Board has determined that this study qualifies as exempt from full IRB oversight.

You should receive a copy of this form for your records. Please sign the next page if you understand and agree to the above. If you do not understand any part of the above statement, please ask the researcher any questions you have.

Agreement to be in this study

I have read this paper about the study or it was read to me. I understand the possible risks and benefits of this study. I know that being in this study is voluntary. If I choose to be in this study I will get a copy of this consent form.

Please **initial** in the appropriate boxes:

☐ I agree to be audiotaped for research purposes.

☐ I agree to be videotaped for research purposes.

☐ Please **initial** this box if data from this research may be used for future research.

☐ Please **initial** here and provide a valid email (or postal) address if you would like a summary of the results of this study to be mailed to you.

_____

Signature: _____ Date _____

Print: _____

By continuing with this research, you are consenting to participate in this study.

Appendix D: Informed Consent Addendum

University of Denver
Information Sheet for Exempt Research

TITLE: Telling our Stories: Students of Color Share their Careers in Mathematics and Education to Inspire Others
Principal Investigator: Lauren E. McKittrick
Protocol #:
Approval Date: 05/25/18

Addendum

This form provides you with updated information about the study *Telling Our Stories: Students of Color Share their Careers in Mathematics and Education to Inspire Others*.

Lauren E. McKittrick, doctoral candidate at the Morgridge College of Education, University of Denver and former research assistant to Dr. , has been assigned as the new Principal Investigator for the research study. Ms. McKittrick will remain in contact with Dr. .

The purpose of the study has not changed. By doing this research we hope to better understand, from the students perspective, the challenges and the opportunities inherent in successfully recruiting, retaining and graduating students from a mathematics program, committed to access and excellence, at an under-resourced, Predominantly Black Institution (PBI).

Participating in the study remains completely voluntary. If you agree to continue with this research, you do not need to sign a new agreement.

If you have questions about this research study or wish to remove yourself from the study, you may contact Lauren E. McKittrick at , or email @du.edu.

Appendix E: Email Correspondence with Participants

Updated Informed Consent

I hope this email finds you and your families well.
I am writing to update you about the *Telling Our Stories* study, which Dr. Phillips and I began working on together three summers ago.

Attached is a letter informing you that I have been assigned as principal investigator for the study. I am excited to continue this important work, and I am fully committed to maintaining the original intent and integrity of the study. If you have any questions, or if you no longer wish to be included in the study please contact me at any time by email, phone or text message.

I will contact each of you shortly -within two weeks- to share your interview transcriptions and to invite your feedback before moving forward with next steps. I plan to send your transcriptions electronically, but if you prefer that I mail a hard copy instead, please respond with a mailing address. Thank you!

Kind regards,
Lauren

Request for Input

Attached are transcriptions of the three interviews I conducted with you for the *Telling Our Stories* study in July 2015.
In an effort to capture your experiences and perceptions as accurately as possible, I want to invite your input before I analyze interview data for this important study. Here is how you can help:

1. If applicable or appropriate:

    - Clarify sections in the transcripts highlighted as [unclear] or [inaudible].
    - Make minor changes to wording, punctuation, or both to better portray your voice.
    - Highlight any portion of the transcript(s) you prefer to remove.

2. Assign yourself a pseudonym: first name and last initial (ex: Lauren M. or Alex P.)

If you would like to provide input, please send your transcript revisions and/or pseudonym to me by _____.
Thank you!

Kind regards,
Lauren

Telling Our Stories: Member Check

I hope you and your family are well.
Attached is the narrative I created from our interviews in July 2015.

This story will comprise some of the data for the *Telling Our Stories* study. My goal was to represent your experiences and perceptions accurately and fairly, and to capture your voice so the reader can essentially 'hear' you within the narrative. For context, I renamed xxxxxx xxxxxx College (xxx) to "CPC" and assigned you the pseudonym "___". Other names and locations may have been removed, abbreviated, or changed to preserve confidentiality.

I would like your approval and input since this is your story! Please send any revisions or changes to me by _____. If I do not hear from you by that date, I plan to move forward with final steps of analysis and synthesis.

Dr. Phillips and I both deeply thank you again for your participation in this important study. On a more personal note, it has been an honor to write your story.

Kind regards,
Lauren

Appendix F: Interview Fieldwork Notebook Excerpts

Personal Memo: July 7

I arrived at Clementa Pinckney College a bit after 10:00 on July 6, signed in at the visitor's desk, and asked to be directed toward the Mathematics Department. Before I walked past the elevators, I heard my name. It was C. F., welcoming me to the building and to xxxxx. As we walked down the hall we chatted a bit about her studies and her tenure at CPC (since 2008). She showed me into an office, told me to make myself comfortable, and offered me some coffee. She mentioned that she wanted to have it ready for Dr. Phillips because he would definitely ask, and we teased a bit about how much coffee he drinks. I said that I think that is where he finds his energy. Dr. Phillips arrived a few minutes later.

Personal Memo: July 9

Dr. Phillips has not been able to secure a room for me to use, and so Professor F. is allowing me to use her office. Which is really nice! It is so much easier when I am not moving from place to place, always packing and unpacking, sitting in the waiting area and unable to listen to recordings, prep for future interviews, etc. Except. Students see the light on and pop in to say hello to Professor F. Other interviewees knock on the door to see if I am in here and available. Somebody needed to print, and Professor F.'s computer is connected to the printer. He set up his file, booted up the computer, and then realized he needed a pass code to log on. So many interruptions. One interview was interrupted four times. It makes it tricky to maintain the flow of a conversation, for the participant to maintain [his/her] track of thinking...

***

Professor F. said that when Dr. Phillips had this office (I am sitting in her office now, on one of the chairs opposite hers.), students would leave their things in his office. She inherited his office, and students leave their things in her office – there is no other place to leave them. This office, aside from the many interruptions, is a nice place to hold the interviews. I have situated myself nearest the wall, but on the door side of the desk. I tell participants to make themselves comfortable: some sit in Professor F.'s chair while other sit on the same side as me. xxx sat on my side, leaning in close as he shared his stories and beliefs. xxx also sat on my side, facing sideways so I could see her profile as she shared her stories. Her daughter dropped by at one point: peeked in and I smiled and waved – then she came in, hugged her from behind and stayed for a moment. xxx did not miss a beat with what she was saying. Her daughter silently left the room.

Personal Memo: July 14

The more I walk up xxxxxxx Street towards the college, the more I enjoy it. There are several eateries: Chinese, Jamaican, pastries, naturopathic foods. There are several convenience stores and delis, a barber, a beauty shop, and a place to get your nails done.

Different smells, but the same people nearly every morning, opening up shop. A man who sits next to the rack of carpets and runners, most of which have the same tape as every day last week. A pile of birdseed is out every morning adjacent to the grocery store, next to a chain link fence cordoning off what seems to be a construction site. This morning about two dozen House Sparrows were behind the fence, the ones who were partaking of the seed hopping through to get away from me walking by. One pigeon continued to eat as if it did not notice me walking so close. Every afternoon a table is set up on the curb, in the shade of a tree and next to a bench, a few elderly men playing dominoes, many others standing or sitting nearby. Speaking French. I hear a lot of French and other languages that I cannot identify as I walk down the street.

The math building itself (well, math, nursing, and I'm not sure what else is housed in this building) is a beautiful structure. Modern, universal design at the entrances (rather than just one, obviously ADA compliant entrance), a large reception desk where people sign in – students, visitors, faculty alike – lots of windows and light. Tables and benches are everywhere and the students gather in twos and threes. The math department has a place for tutoring, complete with computers, tables and chairs, and several white boards. Beginning at about noon each day, students gather and I can hear them working with one another on the math. Some very basic – such as positive and negative integers, some much more complex and beyond my understanding.

Appendix G: Stories Still Untold

This study originally included seven participants. Three participants grew up outside of the United States and so their experiences fell outside the scope of this study. However, their stories and perspectives are too important to fully exclude. These participants reflect a considerable proportion of the students who attend CPC. International students, permanent residents, and naturalized citizens also represent a substantial proportion of students who attend American colleges and universities, and whose children grow up in the P-20 education system. Our future success depends on understanding their stories and perspectives too. Below are selected excerpts from raw interview transcripts.

<Files\\Transcripts Participant 2>

my mother, like I said, my mother is somebody that didn't really go to school for far. Let's say third grade, she know how to write her name, right? She know how to sew. But all I'm say saying, whatever she was telling us to do is for everything that she learn from her, her grand- you know, her mother and everything, so. Ya. Because I believe my mother use to tell me, "Son, I want you to go to school." She didn't know the name was math, she say you have to be good at numbers.

But, if the house is not clean she would say to me, "Go clean this." If she want me to pile up something, whatever she want me to do in the house, whether bring wood for the fire to cook, but she knows that I need those things and that's supposed to be my responsibility. As a matter of fact one time when she just started doing this, she didn't tell me "oh, you have to do this, you have to do that" as I get older and by asking me over and over again, and that's become my responsibility.

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And your job was, what? To be recipient. You have to understand what they telling you, and you have to be willing to do it. Even if you don't know it. But, as a student they understand that sometimes they teaching, you don't understand it. You have the right to say I don't understand that. They will explain it to you, all the probably require that you have a tutor at home or something. But our job was everybody was there to succeed. And only thing about it as a student, and at you call my time, even if I see something in the school I didn't really like, I don't think that would be a good thing for me to go home and tell them, because then I'm gonna to take it in my corner. They will always tell me, I

didn't send you to school to make the rules. I send you to school to follow the rules, make sure if you don't like it. Graduate. Pass this class and when you get to the next class. That's what my life was.

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I was in the next college that I teach not far from here, and I was telling my class of the student and I'm telling them about the component being a student. You as a human being, okay fine. Because you choose, you say you know what? I'm going to school. That don't make you a student. Oh, because you leave your house. That don't make you a student. Because there is things that come with it. You need books. You need materials. You need time. You need peace. You need willingness. You have to learn because between me and you if you are a student, I know something you don't. I'm here to give you. But you have to put yourself in a mindset where you can receive whatever I'm giving you. So then time I'm in the class and I can tell. Nobody have to tell me that, I can tell some students, they've been tormented. Maybe they have some personal problem I don't know about. Some of them, they going through bad divorce, some of them they in bad relationship. So all I'm saying to you, same thing like a car. You look at the car, you study it's whole. But if you coming to a mechanic to take away the parts, you will see how many parts make the whole compact thing. Students, see some of the same thing.

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I would like to know that if when I'm looking at student, to see, you don't show me you're coming by accident. Certain students come here, they put their pencil behind, they worry about their tattoo, their piercing, something, and even if I'm talking math with you, well they leave the math to go to their tattoos. You didn't come here for tattoos. There's so many place, you can get tattoos any time. So I want to know, I mean I will love to know that you as a student… you know why you're here. You know that at one point you decide. I want to go to college. And when you do that, like I always tell them. Don't let somebody speak for you: Speak for yourself. What I mean by speak for yourself: Show me. Don't tell me. Because if you a student, by what you do, by the way you walk, by the way you do your homework, by the way you do the attendance, by the way you treat your peers and your professor and everything. Believe me, at some point there will be one professor, maybe more than one who will say, "oh! Something about that student." And that's the way they will start something.

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So meaning when you come here, if you have a dream and that's the reason I always tell my student, even though if I'm teaching right now, don't let somebody talk for you. Talk for your own self. Because if you have a goal in your head, if you're on a mission, people are not gonna know if they don't see. Because they say actions speak louder than word. They want to see actions. So they see like, "okay? You taking your school seriously." They see you on a mission. When you talk to people, when you tell them

what you want to be, you want to graduate, you want to go further, so that's how you become a [research site omitted] student. But here, if you at the school, student is not one size fit all. Some just come and sit. Some come here because mommy and daddy tell them to come to school. Some come here because they want to learn, they want to graduate, they want to make a change in their life to be successful and they choose school as the bridge.

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I will tell you when I was here that's exactly what I was doing. And I will tell you when I was here, not all the professors was like friendly or good. And I tell you because… say that I'm saying. Dr. R- was the first person to tell me, "You know what? If you go to somebody's office you ask. If the person is willing to help you, take the help. If he's not willing to help you just say 'have a nice day' because they will be half-graduate. Don't fuck with them." But he says, "No matter what, it don't matter how bad the school is, always a few people that's willing to help you." And that's the reason why I carry this with me to help the student, I'm one of the person, that is here willing to help you. Even if you ask me sometime I don't know, I will go with you looking for the information and help you to get you there.

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<Files\\Transcripts Participant 6>

Oh okay let me – for instance – for the tutoring, I have some freedom for my schedule, so I – for instance if I'm taking classes in the afternoon, I set my tutoring hours during the morning. So from – let's say from 8 to 5 I'm in the school 3 to 4 days. And then in the afternoon this is the family life when I go – I do what I can, going outside with the kids and do some other activity. Then when everybody went to sleep from 10 and maybe 12 and 1, I do homework and if I'm doing some research, I do it. So I went to sleep at 1 o'clock and woke up at 6 o'clock. And at 6 o'clock dropped the kids and wife and then 8 o'clock start again. And then on Friday I pick them up early because it's the Sabbath and then we go to church, we spend the day, activity together and on Sunday we do laundry and other things. Ah, it was not easy, because family requires time and the kids requires time. Sometimes my wife would yell at me, I mean so to speak, because she doesn't really have quality time with me. That's another problem, and the kids—them-- once they need the time they just come to you; so I had to stop everything and be with them and wait until they sleep nine, 10 o'clock, and come back. And the church-- it's the same thing. So when I'm – most of the time I prepare the activity for the church on Friday night because on Friday night to Saturday evening we don't do anything – any secular activity. It's the Sabbath so we – I focus mainly on church activities. You know planning, preparing meeting, I'm a preacher also – preparing sermon, the research for the sermon. The Friday afternoon sometime I go to sleep late, but, so I could wake up at nine, ten o'clock to go to church. Yeah, so, I mean, always something – I'm always doing something. So my brain constantly, you know, working, when stop with school, church, and then…

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I think research component is very important. The research. Engage the student in research. Because that faculty member, I wouldn't have a close relationship with him, if I was not doing research with him. I think it's a very important aspect that can help in retention. Because not only the student learn the material better; because when I was doing research I had to study like any class even though I didn't get any grade, but I had to study. It's like, I was not motivated because I would get a grade, but it's like I want to see, I want to know, I want to understand. You see, if the college can spark that interest in the student from the get-go, from freshmen, the retention will be – I mean – will be, I should say, substantial. Why? Because, myself, I had the experience. If it wasn't for research, (laughter) I wouldn't – I mean, a lot of things that I benefit from school, I wouldn't because of having –some kind of research activity going on.

You see, and then the research fostered – fostered what you learn in the classroom, and then help you strengthen your weaknesses and then also create networks. I think to me it is key. And then also, with the research also you'd be able to engage the student. They will see that, hey, they're not just a number. They don't just come to work, but be part of what's being done in the college and then be part of what is being done in the department. You see, once they have that interest, I mean, most likely they will stay. They will stay. So that's my experience. That they will stay.

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But I'm not satisfy because I made a mistake. A mistake I can share was that I thought that the system needed people like me.

When I say people like me, people who have the drive to teach mathematics. But when I was invited to be part of a teaching program, and I went and complete all the requirements and then I got a job with the public school; but what I realized that people in the school system— they don't really need you to come to really push the kids to think. They just have their recipe. They just expect you to just follow their recipe. That was my shock, you see, and then that was my disappointment too. But in the end I left the system, which is – I mean the public school system

But in the public school system I didn't have that chance, even though all the students really like the way I taught them, but the administration, since they have their own views, own thing that they wanted me to follow. So I was not successful at that point. So that's why I signed my resignation, which was a big mistake with respect to benefits and security

I spent two years, two years in public school. One of the problem I had with the public school system with myself I like – I've been doing research, you see, but the public school system is that… to me I went to work from 6 o'clock to 5 PM, and then come back at six every day— it's like that. So to me there was no progress because there was no way that I could increase my breadth of knowledge, because you're doing the same thing

repetitively— same thing, same thing over and over, and then ah – it's like I was stuck with doing this, and that was something that I didn't really like. On the other hand… but the students, I saw the need. I saw that they were willing to learn because there I learned that everybody can learn— everybody especially can learn mathematics if they have the right person that can teach them, you see, or who's willing to go where they at, and then bring them up, they have the … you see, they can. That's what I've, you know, realized.

Because one year they gave me what we call bottom third. I don't know if you know that term. Oh yeah, you're a teacher I forgot you're a teacher. Bottom third, you know, not only bottom third. A lot of Special Ed student, a lot of repeaters, you see. But, you know, I managed to help 49% pass that year on the [state exam name omitted]. Yes, I know the [state exam name omitted] it's not really you know… but they were satisfied that they pass the [state exam name omitted] and they could graduate from high school; so that was one of the thing that I really like that I was able to do for them. And also they would come to me and tell me, "[participant name omitted], you know, we really like the way you teach…" They will not hide. If they don't like something they will come and tell you – in your face, you know, which I like. I like people who telling me the thing like it is. Don't sugarcoat it; tell it like it is.

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<Files\\Transcripts Participant 3>

I have a big sister. My big sister, she started high school way before me but she was not able to continue and finish. She had to drop out because she was not able to get into the government school, which was for free. So my mom had to pay, my dad, my mom and dad had to put money together to pay for her, and it's same for my little brother and my little sister. They were paying every month for three other, for three other kids. Except me. So, that's one of the reason my big sister was not able to continue, because she couldn't pass the test to be in the free school, and to be paying every month my mom and dad couldn't keep up until she graduated. But, we had a good relationship. My sisters and I. I try my best to help my brother, my little brother and my little sister with little that I knew while I was doing high school cuz I was some step ahead of them. But unfortunately my two sisters didn't get to finish high school but my brother did. But he didn't get to college.

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when I was a student here and I was tutoring there was no tutor to do statistics. I was the first tutor to be able to tutor statistics. I was the first one and I was the only one for… many semesters for like four semesters. And there is a lot of nursing students in this school. This class is for nursing. It's a math class call xxx, Elementary Statistics. There's a lot of nursing students at [research site omitted] would always offer this class, like four, three to four session, Math xxx. So sometime the math department is full of students, most of them are doing statistics and I'm the only one. So one day I sat down and speak to myself and say "How can I change that?" Because being the only one doing

this, it's really not working out. It's not working out for me, and also for the center. So what I do, I organize a workshop during a summertime for all the tutors. I taught them the subject and then since they are all math majors, they know they have good knowledge about mathematics. So it was very easy for them to learn the subject and the following semester all of us were able to do statistic, to tutor statistic and now, I didn't have to be dealing with all the students, me alone dealing with all the student. So I think that that workshop help a lot. A lot. Till after we transfer from the other building to this building, some of the tutors go with the student who were tutoring statistic because of that workshop. So, all the professors, to come back to your question, all the professors, they know that if I was able to organize a workshop for math majors, who were tutors and they sat down and learn the subject from me.

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Around that time, there was only one professor teaching that class here at [research site omitted]. And one semester he started the class and, I don't know what happen along the semester, he couldn't continue. He had to go back home. He's from Nigeria. I don't know what happened, he had to leave the country to go to Nigeria.

And the day he called the chairman to let him know what the situation is, I was in the math department doing some tutoring. And as soon as he hang up the phone with the professor, I meant, I'm talking about the chairman… he came to me and told me, "Today you gonna be teaching the class until the semester finish." I was a student and he has confidence in me enough to send me to the classroom. To go and teach the class.

I was not welcome to the classroom. They were upset. They were saying, "He's a student like us. Why now he's the professor, why he's gonna be teaching us? He's a student, he's not even graduate yet. He, he does not even graduate yet." They were very upset. But that was… I did not let that intimidate me. One of them even said, "I want to be taught by professional." Then, you know what my answer was? I ask the student, "What is a professional?" He couldn't even answer the question. What is a professional? A professional is someone who has a degree? And can't even do what he's hired to do? Or you want someone who can come here and explain to you what you need to know? And I was able to step up and make them know that if they continue acting like that, they gonna be the one to lose. I'm not losing anything cuz what they gonna do. Cancel the class at the end, only two months left for the semester to finish? They have no one to teach it, but they know that I can do it. You, you don't want me to do it, so what they gonna do, cancel the class and then you have to take it over? A professional is someone who can come here and explain everything to you, everything that needed to be explain in a such a way that you will understand and you will be able to do it on your own. Don't you think I can do that? They couldn't answer the question because they come to me all the time, I make them understand. So from that day, after I speaking, I had speaking something to them like that, so they gave me a chance. To do the class. (laughter) And I took that chance and I think I did pretty well.

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College is about setting a goal. Setting a goal, and know what step to follow to achieve that goal. So it's, for people who don't go to college, who don't get to go to college, when people speak about going to college they only see the name of this person went to college. I wanna go to college too. But, you have to be ready. You don't just go to college because you hear the name and you want people to know that you went to college. There is… if you not ready to make some sacrifices, you, it's just the name you gonna have. It's just the name you gonna be able to say that you went to college, but being able to say that I went to college and I graduated, it's gonna be very difficult if you just wake up one day and go register to go to school, and you were not ready to do so. It's not going to- graduating is not going to happen. Cuz, I believe if you are going to college, if you go to college you spend two, three, four or five years and you don't graduate, it's like you waste all this time.