A CASE STUDY OF SECONDARY AND POSTSECONDARY

BLACK STEM EXCELLENCE IN A BLACK METROPOLIS

by

MARK ANTHONY WILLIAMS JR.

(Under the Direction of Walker Swain)

ABSTRACT

All in all, this case study examines the cross-pollination of high achievement and representation of Black high school students in STEM, mechanisms and resources enabling school success in STEM, and school and individual factors that promote high attainment for Black men and women in STEM beyond high school. Qualitative data collection and analysis is performed in the first phase. In this phase, the researcher interviewed 16 uniquely gifted Black alumni and students of Georgia Institute of Technology—a prestigious STEM-focused postsecondary institution located in downtown Atlanta, Georgia.[1] The second phase is a quantitative descriptive analysis that contextualizes the K-12 journeys of the 16 participants representing Georgia Tech. The third element of this study is qualitative inquiry of a large urban school system in Metro Atlanta to investigate their mechanisms that enable school success in STEM for Black students at the secondary level. This study implements the *anti-deficit achievement* conceptual framework to understand how outliers succeed.

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[1] The names of some participants have been assigned pseudonyms to protect their identity.

INDEX WORDS: STEM, Science Education, Technology, Engineering, Mathematics Education, Racial Disparities, Gender Disparities, Intersectionality, Culturally Sustaining Pedagogy, Urban Education, Postsecondary Education, Education Policy

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DEDICATION

As a first-generation college graduate, I feel personally responsible to achieve greatly and capitalize on my opportunities to acquire formal education. In this respect, I am accountable to my ancestors and my descendants beginning with my children Isaiah Amir, Sunday Noelle, and Dallas Fletcher. Kids, Dad dedicates this degree and any succeeding degrees to you—to provide you and your children with a blueprint to high academic achievement and success in education. Your foundation is set. Build on it.

This degree and dissertation—and all of my nearly 30 years of formal schooling to this point—are dedicated to my ancestors who survived the Middle Passage and endured slavery, reconstruction, separate but equal being considered constitutional, Jim Crow, residential segregation, other forms of overt or systemic discrimination, the fight for civil rights, and generational poverty. To my four grandparents, only one of which finished high school with a diploma—as your overachieving yet prodigious grandson, I have vicariously fulfilled your desires for advanced education.

To my maternal grandfather's mother, Willie Mae Davenport (1917-2003)—great grand momma, I made it! Uncommon to the traditions of others, you loved me unconditionally. Before succumbing to Alzheimer's, you clairvoyantly called me "Professor" during my pre-teen years and said I would be some day be a part of academia.

To my great grandfather, Hunter Williams (1913-1997)—my soul feels 70, but I'm only 35. I sense as though I've walked this earth before and viewed the world through the lens of your

eyes as well as the lens of Willie Mae. Thank you for meekly, however passionately, leading your family on your many acres.

To my paternal grandfather's great grandmother, Loucindia Hunter Fleming (1853-1957)—you were 12 years of age when you were freed from slavery. You lived long enough to tell your great-great grandson—my grandfather—about your experiences on the plantation and not being permitted by law to read or write. As your progeny, I proudly write this dissertation.

To my first cousin three-times removed and my great uncle, Chesley Wells (1891-1915) and David Shaw (1866-1892), respectively—you both were lynched in South Carolina largely due to the color of your skin. David, you lived to give your account to a correspondent of the Atlanta Constitution. The story of your survival can be read by anyone using an online search of "Dave Shaw 1892."

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To my closest friends that I consider my younger brothers and sisters—knowing and becoming close with you has been a high point of my life. Going back to 2012, when I first moved to Atlanta and began working at Georgia Tech, you were the first friends I made; and now our bond is lifelong. Having you in my life has enhanced my self-efficacy to build relationships and cultivate friendships on the merits of my character and not based on my last

name and status within a cultural syndicate. Your unending thirst for knowledge contagiously stimulates my desire to grow every day.

To a special someone, a loved one—you've surreptitiously but caringly given me so much love and encouragement for over two decades. The child of an educator, your comprehension of the value of education is most evident in your children. Be it Accountancy, Art, or Student Affairs, their educational pursuits reflect your high intelligence and unique ability to remain sensible and pragmatic in your views of the world.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

> *The pain is definitely widespread, but it is not spread equally. People of all stripes have been affected, but the job losses and the economic pain has fallen hardest on younger people, people without a college degree, people who make less than fifty-thousand dollars, and Black and Brown people.*
>
> —Scott Horsley, NPR Chief Economics Correspondent

Scott Horsley is the National Public Radio (NPR) Chief Economics Correspondent who, on April 29, 2020, summarized a poll—from the month prior—encompassing the economic impact of COVID-19. He referenced the lesser educated as well as African Americans and Latinx as those experiencing the most unemployment as a result of the pandemic (Martin & Inskeep, 2020). The results of this poll are a peek into the sweeping issue of inequities and resulting disparities in our education system of which can be mitigated with the narrowing of opportunity and achievement gaps in STEM at elementary and secondary education levels.

Based on a study of the STEM pipeline from pre-college to the labor market, using National Longitudinal Survey of Youth (NLSY) data, Speer (2019) concluded that genetics, parental involvement, school quality and courses taken are factors that can determine how ready a student is to succeed in school. However, only a few of these factors are within the student's control. For factors within schools' controls—such as administration and high quality teachers—policy must be established and implemented to provide Black students with equitable resources to ensure their success in STEM education.

Statement of the Problem

Science, technology, engineering and mathematics (STEM) is an elemental component in society that systematically provides understanding of the world through observation and research. In addition to female students, disadvantaged children and those of color are most at risk of deprivation in STEM (Moss, 2018; Olszewski-Kubilius et al., 2016). It is important that all K-12 children and students at postsecondary institutions have equal access to STEM education opportunities because a STEM-educated workforce is critical to fostering innovation in national security and advancing the U.S. economy (Burke & McNeill, 2011).

Specialization in STEM—specifically advanced education—enhances access to economic opportunities in the evolving U.S. economy. Research gives dimension to rapid growth in STEM occupations along with high earning potential and low rates of unemployment relative to non-STEM jobs over the next decade (Crabtree et al., 2019; Fayer et al., 2017; Langdon et al., 2011; Rozek et al., 2019, p. 1553). The numerical and computer literacy skills, in addition to other STEM-based skills, are an unquantifiable benefit of STEM training; and these competencies are marketable and invaluable across a variety of disciplines, which provides opportunities for students to pursue a variety of interests. With this is mind, strong foundational knowledge in science and mathematics in elementary, middle, and high school can incite students to declare a STEM major in college and pursue a STEM career (Fayer et al., 2017; Maltese & Tai, 2011; Rozek et al., 2019, p. 1553; Svoboda et al., 2016).

School finance reform at all levels can help ensure that racial and gender disparities are narrowed (Moss, 2018; Olszewski-Kubilius et al., 2016; Marx & Harris, 2006). Policy change that specifically addresses the allocation of funding and resources holistically at marginalized K-12 schools is a necessary force to galvanize equity, particularly in grades 9 through 12. These

holistic changes include, but are not limited to, professional development programs for STEM teachers, increased financial resources to recruit teachers who specialize in STEM subjects so there are less teachers teaching outside of their expertise, and additional capital to expand research laboratories and technology experiences for students.

Wright et al. (2016) prudently provided examples of K-12 programming that nurture and promote STEM development for Black youth. Their findings determined that developing the STEM engagement of young children begins with recognizing their interests, unlocking ideas from their previous experiences, and exploiting their nature to be inquisitive. Additionally, Wright and colleagues concluded that it is essential for Black students to be engaged in consequential experiences that incorporate their identity references as a foundation for learning critical STEM concepts.

Taningco et al. (2008) synthesized existing literature pertaining to the challenges faced by minorities in their quest for STEM degree attainment and employment. They concluded that students are compelled to learn when they are exposed to demanding curricula in elementary and secondary school coupled with an environment that fosters high expectations. As a result, they have an increased likelihood of achieving. Contrarily, these students are at risk of being impaired academically when they are only exposed to inferior instruction and curricula. This is particularly the case when out-of-school learning opportunities are less accessible. These facts highlight the importance of challenging curricula and qualified teachers—for Black students—to endorse equity and augmentation of long-term student success in STEM.

It is important to distinguish historically disenfranchised groups and provide them with adequate resources to succeed. In STEM, not distinguishing race and gender does a disservice to the non-dominant groups of these fields, as it limits their opportunities to successfully declare a

STEM major in college and pursue a fast-growing and profitable career in STEM. Rozek et al. (2019) made this assertion based on their large-scale experiment, whereby emotion regulation interventions were implemented in ninth grade classrooms in an economically diverse high school. Conversely, if we distinguish their uniqueness and provide them with the academic nourishment required to thrive, success will inevitably befall them. The allocation of resources that place students of color, girls, and women within a reasonable starting distance of their majority counterparts is needed to increase interest and persistence of underrepresented groups in STEM and narrow achievement gaps. Policy must be addressed so that schools are held accountable for distinguishing underserved students and tending to their academic needs. This is especially imperative in STEM as achievement gaps between Black students and their White contemporaries exist.

The pressure of high-stakes accountability culture has devalued STEM education over time. With elevated emphasis on standardized testing and benchmark proficiency in mathematics and language arts, holistic STEM education and innovation has been grossly undermined with more instructional time being allocated for math and English, leaving less time for sciences (Burke & McNeill, 2011; Marx & Harris, 2006). These deficits must be remedied in an effort to meet the needs of students from diverse cultural backgrounds and improve their academic outcomes in STEM. Accomplishing these feats can cultivate the desires of students to remain in the STEM educational pipeline, earn a STEM degree, and succeed in a STEM profession.

It is immensely important for teachers to learn to identify, appreciate, and integrate the diverse sensible practices used by underserved students in STEM to assist with their comprehension of scientific and mathematical ideas. All students must have their mathematical designing, scientific understanding, and problem-solving abilities recognized and nurtured in

early grades (Wright et al., 2016). The processes described herein can provide safe spaces for students, whereby their minds are stimulated and science and math creativity is cultivated. King (2017) determined that encouraging students from historically marginalized groups to take advanced courses in STEM fields is not enough to motivate them to remain in the STEM educational pipeline and pursue careers in STEM (p. 11). In addition to this encouragement, it is critical to know *how* these students are experiencing their STEM tracks. The author, Natalie King, came to these conclusions while examining the STEM learning experiences of Black girls in grades four through eight who participated in an informal STEM program.

Purpose of the Study

The purpose of this case study is to provide a comprehensive review of enablers of success for high achieveing Black men and women in STEM. These talented individuals are all from Atlanta, Georgia and surrounding metropolitan areas; and they each matriculated at Georgia Institute of Technology—a preeminent STEM-oriented institution in the nation. The first and most important phase centers on guided interviews of Black alumni and students of Georgia Tech who majored in STEM and who attended high school in Metro Atlanta. After completing this initial qualitiative exploration—whereby uniquely gifted individuals were investigated to determine their enablers of success as academic outliers relative to their African American peers—a subsequent quantitative analysis was conducted. The purpose of this second phase is to complete a quantitative descriptive analysis examining Black-White achievement gaps in STEM at the respective Metro Atlanta school districts where the study participants attended high school. During this quantitative phase, Georgia student level data was gathered from the Governor's Office of Student Achievement (GOSA); and the Metro Atlanta school districts that were quantitatively evaluated include:

- Atlanta Public Schools
- Cobb County School District
- DeKalb County School District
- Douglas County School System
- Fulton County Schools
- Gwinnett County Public Schools
- Henry County School District

Finally, a qualitative exploration of a large urban school system was completed. Within this investigation, the school system—located in Metro Atlanta—was audited to evaluate its promotion and implementation of components of quality STEM education for Black boys and girls. Administrator and teacher perceptions were documented and analyzed.

It is important to note that Black students with STEM aspirations do not have to attend K-12 schools in Metro Atlanta or enroll at Georgia Tech to be successful in STEM. However, these two components—or the intersection thereof—have proven to create compounding benefits in the pursuit of a STEM degree and a subsequent career in a STEM field. Drs. Charles Isbell and Raheem Beyah are examples of STEM success stories having both attended Atlanta Public Schools, earned STEM degrees from Georgia Tech, and now serving as the deans of the College of Computing and College of Engineering, respectively.

Research Questions

In the aggregate, the phases of this case study explicate the overlap of high achievement and representation of Black high school students in STEM, mechanisms and resources enabling school success in STEM, and school and individual factors that promote high attainment for Black men and women in STEM beyond high school. Accordingly, the first phase surveys the

insights of Black students and alumni of Georgia Institute of Technology who currently major in a STEM field and who attended high school in Metro Atlanta. This qualitative phase is guided by the following research question:

1. What are enablers of persistence and success for Black students and alumni of Metro Atlanta high schools who major in a STEM field at Georgia Institute of Technology?

The second phase is a quantitative descriptive analysis of school districts in Metro Atlanta. The participants of the first phase attended high school in the seven school districts selected for this second phase. This phase is guided by the following research questions:

2. What were the extent and variations of representation and achievement in STEM for Black students in Metro Atlanta high schools?
3. What were the extent and variations of disparities within both representation and achievement?

The third component of this dissertation involves a qualitative analysis of a large urban school system in Metro Atlanta. An examination of administrator and teacher perceptions of quality STEM education for Black boys and girls is administered. This study is guided by the following research question:

4. What do administrators and teachers identify as successful mechanisms that facilitate quality STEM education in Metro Atlanta schools for Black students in grades 9 through 12?

Theoretical Framework

This research will implement the *anti-deficit achievement* conceptual perspective. This framework is informed by eight theories from the fields of psychology, sociology, and education; and it focuses on success instead of failure and underrepresentation (Harper, 2010; Harper 2012).

It examines outliers who achieved by means of developing confidence in STEM subjects and overcoming discouraging racial and gender misconceptions (Harper 2010). These outliers each have a list of resources responsible for their achievements and ability to thrive in culturally foreign environments (Harper, 2010; Means & Coleman, 2018).

This framework is largely about the questions presented by researchers as they embark on the journey to improve student attainment (Harper, 2010). Instead of conducting exploratory research into why Black students are less successful on STEM-based Advanced Placement (AP) exams, researchers employing this framework might probe into all enablers of success for these students. Users of this framework should search for markers of success and not deploy antiquated models for evaluating deficits (Harper, 2010; Harper 2012).

Harper (2010) conducted an exhaustive research project titled, the National Black Male College Achievement Study (NBMCAS), whereby 219 Black male undergraduate students at 42 postsecondary institutions across 20 states were interviewed. The aim of this study was to survey the factors that enabled student achievement for minorities in STEM. The students interviewed maintained a GPA above 3.0 while in pursuit of their undergraduate degree. These men were esteemed by their campus student body as exemplary leaders, and they were identified and nominated by administrators and distiguished peers at their institution. Harper gained understanding of how these achievers perservered through challenging circumstances by using trajectory analyses with considerable emphasis placed on the roles of students‘ parents and teachers in nurturing and inspiring their math and science interests (Harper, 2010; Harper 2012). While Harper’s study captures the essence of how Black males achieve as undergraduate students in STEM, this dissertation assesses the enablers of success for all Black students from Metro Atlanta schools.

Significance of the Study

This study is significant for several reasons, beginning with it's articulation of the importance of STEM education at an early age. Additionally, the level of elementary and secondary education for Black students has a tremendous effect on their individual interests and the STEM postsecondary pipeline as a whole. This study highlights the importance of academic preparation for these students in grade school and its direct affect on their STEM persistence and completion at the postsecondary level. In an editorial to bring to bear the critical milestones of men and women on a STEM pathway over the life-span, Ertl et al. (2019) uncovered that student selection of college or university and corresponding major can also be shaped by schooling during the early adolescent years of a student (p. 6). Family, home, and culture vitally influence the academic trajectory of children to similar intensities as schools.

This study is essential because it underscores the significance of early STEM success for Black boys and girls from Atlanta, Georgia, and increased opportunities for them to further their STEM education through various pathway and support programs at Georgia Tech. This study expounds on the complementary connection between Georgia Tech and K-12 schools in Atlanta, and Georgia as a whole, beginning with the *Georgia Tech Scholars Program*.[1] The primary initiative of this program includes the acceptance of valedictorians and salutatorians from any accredited Georgia high school with 50 or more graduates, provided a minimum SAT or ACT score, and math credit at the pre-calculus level or higher. This program has directly benefited participants in this study, enabling them to persist in their journey as high achievers in STEM from a Metro Atlanta high school with matriculation at Georgia Tech. Other Georgia Tech

[1] Georgia Tech Scholars Program

programs of note include the *APS Pathway*[2] Program and the *APS Scholars Program*.[3] The latter, launched in 2014, emphasizes the commitment of Georgia Tech to enroll and graduate the most academically gifted students within Atlanta Public Schools—a district where greater than 80 percent of students enrolled are Black. This is significant considering the Fall 2020 enrollment demographics at Georgia Tech reveal that Black students were the least represented group in nearly all STEM majors (Student Enrollment, n.d.). These facts contribute to the significance of this dissertation study.

This study is important because it provides a comprehensive understanding of the enablers of STEM persistence and success for Black students in Atlanta. This study analyzes the factors associated with high achievement in STEM in addition to the extent and apparent causes of disparities in outcomes along the lines of race, gender, and the intersection thereof. Furthermore, this study is significant because it queries how school resources provide opportunities for Black students in grades 9 through 12 to seek STEM trajectories that will support them through their postsecondary aptitudes and into their careers. Findings from this study will inform researchers and policymakers on existing and innovative mechanisms for schools to improve attainment in STEM education.

[2] Atlanta Public Schools (APS) Pathway Program
[3] Atlanta Public Schools (APS) Scholars Program

Organization of the Study

This case study follows a traditional format, organized in five chapters. Chapter 1 describes the background of the study, the statement of purpose, the research questions, and the significance of the study. Chapter 2 offers a review of the literature relevant to quality STEM education for Black students in a Black metropolis. The review includes these related subtopics: racial and gender disparities in STEM; intersectionality in STEM; influencers in Black STEM; accountability and organization in schools; teacher characteristics; pedagogical practices; resources, recruitment, and retention; and cultural education practices. Chapter 3 discusses the study's research methodology, including the research design, theoretical framework, research methods, sample selection, data collection and analysis, and limitations of the study. Chapter 4 presents the findings that emerged from thematic and quantitative data analyses. Chapter 5, the concluding chapter, presents the researcher's summary of findings, conclusions, and implications for current and future research and practices.

CHAPTER 2

LITERATURE REVIEW

Atlanta STEM/STEAM

Atlanta History

The City of Atlanta was incorporated on December 29, 1847 (Zero Mile Post, 2015). Prior to the abolishment of the Transatlantic Slave Trade by the U.S. Congress, that took effect on January 1, 1808, Charleston, South Carolina operated as a major southern port for ships carrying Africans through the Middle Passage to be enslaved in Georgia and other southern colonies. According to the 1870 U.S. Census, the Black population of Atlanta was 46 percent and would continue to grow every year (African American Experience, n.d.). Five years earlier, after the abolishment of slavery, Atlanta University was founded as the first Historically Black College or University in the South (CAU History, n.d.). Georgia Institute of Technology would not be founded until 20 years after in 1885. Now freed, African Americans migrated to the Metro Atlanta area in search of superior economic opportunities unavailable to them in rural areas of southern states.

Integration of Georgia Tech

In May 1961, Georgia Tech President Edwin D. Harrison progressively set plans in place to integrate the intuition. Harrison believed that peaceful integration was necessary to avoid the federal intervention and unrest that accompanied the University of Georgia (UGA) as students, Hamilton E. Holmes and Charlayne Hunter-Gault, became the first African Americans to be admitted to UGA in January of 1961 after Judge William Augustus Bootle ordered the

admissions of these trailblazers (Fox, 2005; Suggs, 2019). On September 20, 1961, three Black students—Ralph A. Long Jr., Lawrence Williams, and Ford Greene—all from Atlanta, became the first Black students to integrate a university in the Deep South without a court order (Suggs, 2019).

Along with Holmes and Hunter-Gault, Greene and Long Jr. attended Henry McNeal Turner High School of Atlanta Public Schools while Williams attended Booker T. Washington High School of APS (Suggs, 2019; Williams, Lawrence, 2020). Each of the three pioneers majored in a STEM field while enrolled at Georgia Tech. Although Georgia Tech, today, is considered one of the most diverse large universities in the nation—with Asian students representing nearly a third of the student population—Black students are still disproportionately underrepresented (Suggs, 2019).

Atlanta Fine and Performing Arts

While STEAM has not been emphasized in this dissertation, this acronym denotes the inclusion of the *arts*. Within the STEM sphere, the arts must implement math or science concepts and principles. The arts have played an influential role in the Black Atlanta experience with notable music artists like Outkast who ostentatiously colonized hip hop music in the South. The musical group's craft has gorgeously demonstrated the duality of convergent and divergent thinking going back to the early 1990s. Furthermore, they indirectly influenced the establishment of the Georgia Tech *School of Music*'s first degree program in 2006. Similarly, Frederick Douglass High School of Atlanta Public Schools (APS) offers music technology courses in their STEAM program, implementing a groundbreaking software coding environment for music. This free educational software, known as *EarSketch*, was developed by the Georgia Tech School of Music (EarSketch, n.d.).

In addition to fine arts, such as music and architecture, Atlanta is also recognized as a focal point for performing arts. Colloquially labeled, “Black Hollywood,” Atlanta is viewed as a major hub in the film industry. Black actors such as Chris Tucker—the great-great grandson of Spencer Bryant (1865-1946), a former sharecropper of Metro Atlanta—have expertly connected art with Black culture. Now, Frederick Douglass High School of APS proudly hosts a modern dance curriculum as part of their STEAM education program. The following section will discuss racial disparities in STEM.

Racial Disparities in STEM

Based on a three-year, seven-campus study of factors contributing to high rates of undergraduates switching from STEM to non-STEM majors, Seymour and Hewitt (1997) found that many Black students are intellectually bound by over-confidence and poor preparation. This paradoxical psychological quandary limits their ability to pursue and persist in STEM education. Due to systemic marginalization generations before them, many Black students historically attend poorer elementary and secondary schools; and the ones who are able to attend college and declare a STEM major are academically advanced compared to their underprivileged peers while in high school (Crabtree et al., 2019; Seymour & Hewitt, 1997). Consequently, the latter class of individuals develop high levels of self-confidence despite having not been challenged by the rigors of Advanced Placement (AP) or International Baccalaureate (IB) coursework. Upon entering college, these students are frequently consumed by the intensity of college-level curricula offered in STEM programs; and they are at risk of changing their major or withdrawing from school altogether (Seymour & Hewitt, 1997).

Based on a study of equitable achievement in Immunology classrooms at public institutions largely serving minority students in New York City and Southern California, Riestra

et al. (2019) uncovered primary contributing factors to Black-White achievement gaps in STEM. These factors consist of inequalities in socioeconomic status and the absence of educational cultural capital among Black students (p. 2). The parents of these students are often devoid of education beyond high school, consequently limiting the academic, financial, and emotional support they can provide to their children to ensure their success (Taningco et al., 2008). The deprivation of support leads to Black students disengaging from quality learning experiences and merely "playing the game of school." This pejorative colloquialism describes the process of students unproductively rushing to complete assignments and receive a passing score on tests, day in and day out, in an unengaged manner, doing just enough to fulfil course completion and graduation requirements (Fried, 2005).

Many Black students derive from lower-income households and attend lower-quality schools in communities absent of educational resources; and as a result, they are predisposed to poor performance in STEM courses at secondary schooling levels, thus limiting their opportunities for advancement in these fields (Rozek et al., 2019). Moreover, lack of educational technology for math and science at the elementary and secondary levels can severely hinder or impair academic growth and ultimately reduce representation in STEM. High-poverty students of color generally attend schools that are devoid of educational technology which, in turn, inhibits their understanding of critical math and science concepts (Taningco, 2008). According to Rozek et al. (2019), Black students, particularly from impoverished backgrounds, frequently perceive that they are inferior and less important socially than their White peers; and therefore, they experience rejection and anxiety that extends to evaluative assessments that emphasize rank and status (p. 1553). Among the more notable evaluative assessments that accentuate negative emotions felt by Black students—resulting in the burdening of their cognitive abilities—is high-

stakes examinations; and these psychological impediments to success ultimately lead to underperformance on high-stakes assessments, causing an expansion of achievement gaps in STEM (Jungert et al., 2018, p. 492; Rozek et al., 2019, p. 1554).

When minority students sit down for evaluative assessments, the stakes are markedly higher for them, but not simply in a federal school policy context (Rozek et al., 2019). The higher stakes for these systemically marginalized students is personal as their range of resources to improve academic performance is far more limited relative to their better-resourced peers who live in greater affluence and are able to hire tutors and relocate to higher quality school districts (p. 1556). Low performance in STEM courses prior to reaching high school results in significant underrepresentation in a full sequence of STEM courses at the next level, which substantially reduces preparation for a career in STEM compared to that of their more advantaged peers (Maltese & Tai, 2011; Rozek et al., 2019, p. 1553; Svoboda et al., 2016).

Crabtree et al. (2019) deployed critical systems theory to complete a research study examining inequities in gifted education. They concluded that programs specifically designed for gifted students in elementary and middle schools are vital in the preparation of Black students to succeed in advanced STEM curricula in high school, which can influence their decision to attend college and graduate with a STEM degree (p. 204). Even as Black students are recommended for gifted programs in high-poverty elementary and middle schools, gifted specialists are rarely hired because oftentimes too few of total students are recommended for these programs (p. 219). Furthermore, studies have found that urban high schools serving predominantly White students offer nearly double the amount of AP courses as schools serving higher proportions of Black students, consequently perpetuating inequities (p. 207).

In a study examining kindergarten and first grade science achievement using data from Early Childhood Longitudinal Study, Kindergarten Class of 2010-2011, Curran & Kellogg (2016) claim that the Black-White achievement gap in science can be considerably explained by inequality in socioeconomic status (SES), and both, in school and out of school factors as a whole. When controlling for SES, gaps are narrowed due to the strong correlation between race and socioeconomic status although these racial gaps still exist in a major way (p. 280). Next, this literature explicates gender disparities in STEM—specifically in science—and discuss their contributing factors.

Gender Disparities in STEM

The "leaky pipeline" defines the exodus in higher quantities of females from STEM domains compared to males. Women are perpetually a minority group when it involves STEM degrees and occupations, holding nearly half of all jobs in the U.S. economy but less than a quarter in STEM related fields (Diekman et al., 2015; Hsieh et al., 2019, p. 53; Young et al., 2017). Weeden et al. (2020) used data from the Educational Longitudinal Surveys to assess the gender pay gap in STEM major completion among high school sophomores in 2002 who were tracked through 2012. According to Weeden and colleagues, young women are less likely than young men to earn a college degree in a STEM field even though they are more likely to attend and complete college in general (p. 1).

The examination of factors and circumstances that occur early in a child's life is needed to fully understand gender opportunity gaps in STEM. More than 50 percent of women who fall from the STEM educational pipeline have experienced their exit by the midpoint of acquiring their Bachelor's degree; and nearly 75 percent have left the field by the time they've received this degree (Speer, 2019). There is an obvious disconnect women are experiencing while on their

paths to STEM degree attainment. Their interests appear to dissipate but not because of intellectual deficiencies or lack of academic achievement (Ertl et al., 2019; Hoferichter & Raufelder, 2019). Instead, a dearth of investment in their STEM interests is a leading cause of the leaky pipeline (Hoferichter & Raufelder, 2019). An absence of early investment into the engagement and participation of young girls in STEM can infringe upon their ability to narrow gender disparities in STEM outcomes (Ertl et al., 2019, p. 6).

As other research examines gender disparities in STEM at macro levels, this study quantifies the influence of high-stakes accountability testing culture on STEM educational outcomes of Black students in Metro Atlanta high schools. This research evaluates gifted Black students and those with advanced STEM tracks to determine factors that enhanced achievement. The research will aim to conceptualize student choice of college STEM major as a function of their STEM journey and mechanisms that enabled their success.

Intersectionality in STEM

Black women are disproportionately underrepresented in STEM in the U.S., relative to Black men and White men and women, as their intersectionality often begets multiple systems of oppression (Charleston et al., 2014; Sparks, 2017). The compounding disadvantage of each intersection is added to their experience (Sparks, 2017). A key contributing factor to their underrepresentation is the alienation they often feel as they are frequently one of the few Black women in their classrooms or laboratories (Charleston et al., 2014). Charleston and colleagues made these determinations in a qualitative study of 15 Black women who were interviewed to examine the marginalization they experienced while pursuing STEM degrees, particularly in computing sciences. Women as a whole are underrepresented in STEM as stereotypes contribute to their preference for non-STEM degree programs. Conversely, in life sciences such as Biology

and other Biomedical sciences, women represent the majority of students in degree programs (Koerting, 2018).

Young, Young, & Paufler (2017) synthesized existing literature surrounding the STEM enrichment of girls of color through culturally relevant pedagogy. They concluded that girls of color inordinately require gender responsive pedagogy and instruction in settings that highlight STEM due to persistent gender and racial marginalization in these fields. Introducing young girls to leaders in a particular field during their early formative years can have lasting positive effects on their outlook toward specific academic genres. Influential figures such as Dr. Mae C. Jemison, physician and engineer, and Dr. Alexa Canady-Davis, retired neurosurgeon, are excellent examples in STEM for young Black females to be introduced to. Experiences such as these put *possible selves theory* into practice and operate as forces of inspiration for young girls to pursue STEM careers.

Influencers in Black STEM

Black STEM Parents

The first teachers of Black students before they begin elementary education are their parents. Parents and corresponding relatives play an integral part in introducing students to STEM and cultivating their ideas and understanding (Wright et al., 2015). Qualitative studies have found that informal learning experiences of Black youth—under the supervision of a parent—are largely responsible for elevating their interest and engagement in STEM once they reach secondary and postsecondary education levels (Lee et al., 1999; Wright et al., 2015).

Informal practices that can be implemented by parents are not dependent upon the parents being college educated. It can be as simple as providing their children with timetables and other basic computational math problems to solve. These education opportunities go a long way in

stimulating the math interests of students. Of course, historical marginalization might limit the education level of a Black parent or their opportunities to spend extra moments with their child nurturing an environment of education enrichment.

Black STEM Teachers

It is extremely important for teachers to stimulate their Black students' interests in math and science. Previous studies have determined that preparing Black students for the math and science sections of standardized tests can disinterest the ones that are mathematically and scientifically gifted. In these scenarios, Black students feel unchallenged in terms of developing the mindset of a mathematician or scientist; and they are unable to connect these subjects to their own cultural experiences. It is imperative to point out that standardized testing in math and science is not equivalent to advanced-level STEM course taking. All in all, the pressures of math and science educators to prepare their students for standardized exams in elementary and secondary environments can suppress the STEM identities of these students. Black students with a robust foundation in math and science are in the best position to obtain a STEM degree at a postsecondary institution (Wright et al., 2015).

With the authorization of the *Every Student Succeeds Act (ESSA)* in December 2015—and the elimination of "adequate yearly progress" and 100 percent proficiency mandates—schools and teachers now have a more practical path to focusing less on standardized tests and more on the individual math levels of each student. They are still obligated to ensure their students are proficient on state exams as one of three academic indicators. However, schools are now able to define their own short- and long-term goals. It is important to note that the test-based accountability provided by the No Child Left Behind Act of 2001 (NCLB) produced large gains

in math achievement for Black students and those receiving free or reduced price lunch in the fourth grade (Dee & Jacob, 2010).

While other studies have broadly assessed opportunity and achievement gaps in STEM, the work in this dissertation conceptualizes the variables and factors that created school environments of high student attainment in STEM for Black students. Utilizing Georgia school data from the Governor's Office of Student Achievement (GOSA), test scores were disaggregated by race for students distinguished in STEM subject areas to examine disparities at Metro Atlanta high schools. The following section and corresponding subsections will describe the resources needed by Black students to ensure their opportunities for success in STEM are maximized.

Accountability and Organization in Schools

There is a distinct correlation between the distribution of course takings in schools and student achievement. As such, when advanced course takings in STEM are offered, many students enrolled in these courses have proven to find their footing and eventually thrive as a result of the culture within schools. Conversely, in public schools, the distribution of achievement is less equitable as a result of the wide variety of courses and corresponding ability levels of students. Positive expectations by teachers and schools are needed in order to effectively educate traditionally marginalized students (Lee & Bryk, 1989). Research has discovered that historically disenfranchised students, particularly in urban schools, increase their academic performance when their teachers hold them accountable with high expectations (Rodriguez, 2006).

Teacher Characteristics

To provide students with quality STEM education, quality science teaching must be anchored in three dimensions: scientific and engineering practices, crosscutting concepts, and disciplinary core ideas. It's imperative that these dimensions are interwoven together and integrated into standards, curricula, instruction, and assessment as the whole model is greater than the sum of its concepts (National Academies of Sciences, 2015a, p. 28). Moreover, research suggests that quality science educators are grounded in college-level coursework of the science genres appropriate for the grade levels and age groups they intend to teach, and that they have command of various pedagogical approaches required to stimulate and sustain the interests and intellectual growth of their students (National Academies of Sciences, 2015b, p. 73; National Research Council, 2011, p. 25). While other studies have independently and broadly analyzed teacher characteristics that contribute to quality education, this study presents a thorough analysis of high student achievement in STEM and the characteristics of teachers that contributed to these academic successes.

Teacher Preparation

Quality STEM education is dependent upon early and persistent preparation and professional development for K-12 teachers (Marx & Harris, 2006; Nadelson et al., 2012; Young et al., 2017, p. 29). This preparation provides the foundation for future expansion of content area expertise and pedagogical growth based on the implementation of a teacher professional development research project by Nadelson and colleagues. The connection between teachers' comfort and contentment with their pedagogical practices affirms the need for professional development designed to boost these characteristics of STEM teachers (Marx & Harris, 2006; Nadelson et al., 2012, p. 70; Young et al., 2017, p. 29). Additionally, as preservice teachers equip

themselves academically with more college level science and mathematics courses, their comfort level for teaching STEM is improved (Marx & Harris, 2006; Nadelson et al., 2012, p. 75). There is a positive correlation between the comfort and pedagogical contentment of teachers and their competencies and effectiveness in teaching STEM, which ultimately leads to higher quality STEM learning for students (Nadelson et al., 2012, p. 70).

Content Area Expertise

In science, adequate content area expertise is necessary to provide quality science education; and this perspective has been widely accepted and refined by many educators of science (National Academies of Sciences, 2015c, p. 101; National Research Council, 2011, p. 20). In order for teachers to shape their content area expertise, they must have a firm grasp on *knowledge of content and students*, *knowledge of content and instruction*, and *knowledge of content and curriculum* (National Academies of Sciences, 2015c, p. 101; Young et al., 2017). Cultivating knowledge in these three domains can help meet the needs of students from varying cultural backgrounds and academic starting points (National Academies of Sciences, 2015c; Young et al., 2017).

For beginner teachers, there are challenges faced to acquire content area expertise, which heightens their necessity for learning and practicing science content (National Academies of Sciences, 2015c, p. 104). This is necessary to increase their confidence and self-efficacy in teaching science and other STEM subjects (National Academies of Sciences, 2015c, p. 104; Young et al., 2017, p. 29). This importance doesn't only extend to beginner teachers new to the profession, but it's also imperative for experienced science teachers being introduced to a new grade level or discipline in the field to learn science content and build their confidence (National Academies of Sciences, 2015c, p. 104). In order to provide quality science education, schools

and administrators need to support experienced teachers as they learn core ideas as well as how students can thrive in the content areas of new disciplines (p. 105). Quality STEM education mandates that content area expertise of high school science teachers be more practice-centered and inquiry-oriented for students as opposed to traditional textbook-dominated instruction that broadly covers set curricula (p. 107).

Successfully teaching inquiry-oriented STEM is challenging and requires comprehensive knowledge and familiarity (Nadelson et al., 2012, p. 70). However, evidence illustrates that inquiry-oriented content area expertise is extremely beneficial for increasing student learning in STEM as it provides authentic project-based learning activities to students, engaging their interests as they identify with STEM professionals during these activities (p. 70). Professional development in inquiry-oriented expertise is even more important for STEM teachers teaching outside of their expertise (p. 71). As educators elevate their teaching efficacy—their effectiveness in the classroom often measured by student academic achievement—they are more inspired to implement inquiry-oriented lesson plans (p. 75).

Pedagogical Practices

Quality STEM education requires pedagogical emphasis to shift from teaching detailed facts to immersing students in hands-on project-based learning (National Academies of Sciences, 2015a, p. 28). To best comprehend and apply scientific ideas, students must model science and intelligently develop explanations for the process and results. By engaging in project-based learning activities and actively exploring real-world phenomena, students can come to understand the nature of scientific discovery as opposed to viewing science as abstract facts. By using concepts to conduct scientific investigations and build their own explanations, students are able to observe and understand the relevance of these concepts and even engage in critical

perspectives on scientific claims. All of this involves *doing* science rather than *learning about* science, as research supports student in-depth participation as a fulcrum to their development of science content knowledge (p. 29).

To create a school atmosphere that allows students to flourish in science, students should be taught to summarize information acquired from reading science-related magazines, journal articles, and web-based resources. This pedagogical practice is more productive than students simply reading science textbooks and answering end-of-chapter questions. In classrooms with high quality science education, teachers are inspired to create scientific investigations with a wide array of possible outcomes to students' questions. Collectively, these outcomes lead to deconstruction of scientific ideas to improve upon students' understanding of core concepts. Instead of passing out worksheets after teaching a standard science lesson, teachers should guide students in the development of their technical skillset as they produce journals, reports, posters, and other forms of media presentations that can be utilized in their science postsecondary and career pursuits. All in all, pedagogical practices involved in quality STEM education requires schools and teachers to support all students as they engage in high level learning opportunities (National Academies of Sciences, 2015a, p. 39).

Resources, Recruitment, and Retention

Through the synthetization of scholarship from several academics researching teacher quality, Wilson (2009) concluded that quality STEM education requires recruiting, preparing, developing, and retaining quality STEM teachers (p. 1). Though recruitment of teachers is a chief objective for schools and districts that cannot be ignored, retaining teachers is arguably of greater importance considering teachers typically improve incrementally during their first five years (National Academies of Sciences, 2015b, p. 77; Wilson, 2009, p. 4). Regrettably,

according to Wilson (2009), nearly 30 percent of teachers across the nation leave the industry for new careers within five years of beginning. This teacher attrition—accompanied by frequent loss of high quality STEM expertise—has a residual impact on schools, districts, and most importantly, students. Schools serving predominantly Black students suffer the most as income and achievement gaps are intensified with teacher attrition (Ingersoll, 2003; Wilson, 2009, p. 4) or even teacher migration—the transfer of educators to different teaching jobs at other schools (Ingersoll, 2003, p. 2).

Human and Community Resources

An unsung but prized component of quality STEM education is an effective principal that can advance teacher contentment and academic progress of students (National Academies of Sciences, 2015d, p. 194; Wilson, 2009, p. 5). These executive school administrators must create partnerships between their schools and outside institutions to expand the professional capacity of teachers, build professional communities for teachers, and be proficient in the principles of innovative curriculum and learning theory with a complete understanding on how to reach students of diverse populations culturally, socially, and emotionally (National Academies of Sciences, 2015d). Furthermore, effective principals help cultivate quality science education by advocating programs, championing resources essential to professional development of all faculty, and successfully managing all bodies within schools (National Academies of Sciences, 2015d; National Research Council, 2011, p. 27; p. 194; Wilson, 2009, p. 5). They are also capable of analyzing teacher instruction and providing useful, formative feedback, assessing teachers' capacity to be effective (National Academies of Sciences, 2015d, p. 194). There is a large body of evidence pointing to the dependency of student achievement on effective leadership, particularly in high-poverty schools customarily educating mostly African American

students (National Research Council, 2011, p. 25; Wilson, 2009, p. 5). However, these schools encounter substantial difficulties in recruiting and retaining effective principals and school leaders (Wilson, 2009, p. 5).

Extracurricular resources, either engendered by parents or by schools, elevate the quality of STEM education for students (National Research Council, 2011). Whether it be museums, after-school clubs or programs, or other research opportunities, these resources promote student engagement and make learning more complete and relevant (p. 7). Unquestionably, STEM-focused grade schools—or schools that provide STEM apprenticeships and internships—greatly contribute to quality educational involvements for students and families with high STEM aspirations, as these specialized schools benefit from a high level of resources and are occasionally exempt from uniform state testing requirements. These schools often provide advanced curricula that broadens and deepens STEM learning over time, more instructional time devoted to STEM, and inquiry-oriented research practice with sophisticated laboratory equipment. Students privileged to attend these schools, or participate in STEM-focused programs in comprehensive schools—such as Advanced Placement (AP) or International Baccalaureate (IB) for advanced study in science and mathematics—are more likely to remain in the STEM educational pipeline, earn a STEM degree, and succeed in a STEM profession relative to their peers who encounter different involvements (p. 9).

Funding and Finance Systems

An essential component of quality STEM education is funding, specifically, to hire and retain effective teachers (King, 2017, p. 1; Wilson, 2009). However, the current labor market for STEM teachers presents substantial challenges to hiring highly qualified educators (Marx & Harris, 2006, p. 472). Marx and Harris (2006) examined opportunities and obstacles for science

education in elementary and middle schools in the context of test-based accountability provided by NCLB, and they concluded that school funding formulas must be adjusted to allocate greater resources specifically for the purposes of recruiting and retaining the very best teachers of STEM (p. 473).

Most students graduating from college with STEM degrees avoid careers in education, understanding their earning potential is higher in non-teaching professions. Subsequently, a shortage of quality STEM teachers is created (Burke & McNeill, 2011, p. 5). If funding were increased at local, state, and federal levels to hire teachers holding STEM degrees, these shortages could be ameliorated and schools could provide better quality STEM education (Marx & Harris, 2006). Consistent quality can be accomplished with the increase of faculty resources, advanced curriculum materials, commitment to teacher education, and updated equipment and facilities (Marx & Harris, 2006, p. 473; National Academies of Sciences, 2015d). As previous literature examines resources and answers the question of why money matters for America's schools, this study explores the mechanisms, systems, and structures that enable Metro Atlanta schools to offer quality STEM education for girls and students of color. This study quantifies school STEM ratings as a function of teacher professional development and school resources, and it also examine the effects of school related mechanisms on the abilities of these schools to recruit and retain high quality teachers of STEM.

Cultural Education Practices

The U.S. continues to prioritize maintaining a competitive work force in STEM (King, 2017, p. 1; Stevens et al., 2016, p. 948). Minority citizens and those who identify as female are critically important to increasing the quantity of STEM professionals because of the inclination for these underrepresented populations to bring unique perspectives to the field. Therefore, it

often in the best interest for schools and education practitioners to invoke cultural education practices to interest and engage female students and students of color so they remain in the K-20 STEM educational pipeline (Stevens et al., 2016, p. 948). Table 1 provides a side-by-side breakdown of culturally *relevant*, culturally *responsive*, and culturally *sustaining* education practices.

Table 1. Comparison of Cultural Education Practices

	RELEVANT	**RESPONSIVE**	**SUSTAINING**
Inception of Literature	1990 Gloria Ladson-Billings	1976 Courtney B. Cazden, Ellen L. Legett	2012 Django Paris
Teacher Strategy	Focused Proaction	Proaction + Reaction	Proaction + Reaction + Sustainability
Implementation	Teacher lesson plans, activities, and assignments	Teacher responses to questions and situations	Teacher cultivation of cultural pluralism and community
Unique Requirements	Teachers accept their biases	Teacher experience and preparation	Teachers address uncomfortable issues and integrate parents

Culturally Relevant Pedagogy

Culturally *relevant* pedagogy is the collective empowerment of students, building on their customs, traditions, and ideas (Ladson-Billings, 1995b, p. 160; Tate, 1995, p. 169). Deployment of this education practice involves teachers proactively encouraging students intellectually, socially, emotionally, and politically as the students maintain cultural integrity and achieve academic excellence (Johnson & Atwater, 2013; Ladson-Billings, 1995b, p. 160). In addition to fostering high scholastic aptitudes and affirming the cultural identity of students, culturally

relevant pedagogy assists in the development of student abilities to critique social and educational status quos with the objective of challenging inequities perpetuated in society (Johnson & Atwater, 2013; Ladson-Billings, 1995a, p. 469; Tate, 1995, p. 169). Cultural identities are a consolidation of race, ethnicity, social class, gender identification, region, religion, and family (Huber, 1991; Johnson & Atwater, 2013; Wlodkowski & Ginsberg, 1995).

Culturally Responsive Pedagogy

The education practice of culturally *responsive* pedagogy isn't simply recognizing the importance of cultural inclusivity among students, whereby teachers actively deploy lesson plans to connect student cultural identities to subject content (Pappamihiel & Moreno, 2011; Johnson & Atwater, 2013). This practice involves ideas of swift adjustments and responses to unexpected scenarios that demand the infusion of cultural references to empower students intellectually, socially, emotionally, and politically (Johnson & Atwater, 2013; Muñiz, 2019, p. 9). Culturally responsive pedagogy is grounded in the belief that academic knowledge is more meaningful, has higher appeal, and acquired more easily when situated within lived experiences of students (Atwater et al., 2010, p. 291; Gay, 2000).

Instantaneously incorporating educational concepts that identify with a student's culture oftentimes requires practice and experience that is most common among teachers of relatively longer tenures. Obviously, a strong knowledge base of subject matter and an elevated preunderstanding of each student's culture aid in applying culturally responsive pedagogy. Occasionally, a comparatively high level of these three components—experience and practice, subject content expertise, and cultural understanding of students—is not enough for a teacher to adequately administer culturally responsive pedagogy as it is not conceivable for them to be fully prepared for every classroom situation they might encounter (Johnson & Atwater, 2013).

Preparation is the challenge of this education practice; and multiple repetitions are the best learning tools and opportunities for educators.

It is immeasurably vital for teachers to adopt principles of culturally responsive pedagogy, particularly in STEM, in an effort to narrow disparities considering the increasing importance of science in this technology-driven society. The Tuskegee syphilis experiment is a prime example of inequities in access to science knowledge and technological advances in modern medicine (Johnson & Atwater, 2013). These atrocities against humanity can be attributed to an absence of understanding of science by people of color.

Culturally Sustaining Pedagogy

The education practice of culturally *sustaining* pedagogy requires teachers to go beyond relevant and responsive in the classroom (Ong et al., 2017, p. 29; Paris, 2012, p. 95; Paris & Alim, 2014). Culturally relevant and culturally responsive pedagogy comprises of prepared and reactive instruction to assist ethnically and linguistically diverse students to achieve academic excellence and be critically conscious within a framework that identifies with their cultures (Ladson-Billings, 1995b; Paris, 2012; Puzio et al., 2017). Conversely, culturally sustaining pedagogy seeks to develop and *maintain* the foundational values of the two previously mentioned cultural education practices (Ladson-Billings, 1995b; Puzio et al., 2017).

During his quest to investigate whether or not the terms “relevant” and “responsive” appropriately encapsulate the cultural practices of traditionally underserved communities, Paris (2012) concluded that for proponents of culturally sustaining pedagogy, intricately creating instruction relevant to the languages, literacies, and cultural identities of students isn’t sufficient enough for teachers. Instead, there must be a continuous presence of academic excellence, cultural competence—sensitivity and appreciation for the heritage, values, and experiences of

other cultures (Muñiz, 2019, p. 13)—and student development of critical sociocultural-political consciousness in and out of the classroom (Paris, 2012; Puzio et al., 2017). This education practice requires that teachers of all tenure lengths perpetuate and foster—sustain—cultural pluralism (Ong et al., 2017, p. 29; Paris, 2012, p. 93; Paris & Alim, 2014, p. 88; Puzio et al., 2017).

Culturally sustaining pedagogy demands that teachers address even the most uncomfortable cultural issues that students face in their lives, such as law enforcement interactions with communities of color, so that these students might perpetually embrace their evolving identities to observe and dispute social injustice (Paris & Alim, 2014). Though issues might surface from individual students in classrooms, culturally sustaining pedagogy should empower the entire group and influence students to be linguistically and culturally flexible (Paris & Alim, 2014, p. 96; Puzio et al., 2017, p. 224). Furthering concepts of flexibility, it is essential for educators deploying this education practice to create learning counterspaces within which students can interact with teachers and their peers in flexible, responsive ways that invite difference, change, and growth among historically marginalized groups (Cook-Sather & Agu, 2013; King, 2017, p. 7; Ong et al., 2017; Solórzano et al., 2000).

Implementation in STEM

Because of the uniqueness of cultural experiences of different groups of students and the proclivity for their cultures to operate as vehicles for learning science and other STEM subjects, schools and teachers should insert education into culture as oppose to inserting culture into education (Johnson & Atwater, 2013, p. 93; Pewewardy, 1993). An example of this contrast is the proactive implementation of African American studies to STEM subject content in the classroom during Black History Month. In these instances, teachers preemptively plan to

celebrate and elaborately discuss notable Black contributors such as NASA physicist Katherine Johnson and open-heart surgeon Daniel Hale Williams. By infusing culture into education on a temporary basis, the enthusiasm to learn for female students, Black students, and the intersection thereof can potentially wane and not sustain after February has concluded. On the contrary, a teacher of a computer science elective can reach into his or her knowledge base and reference Black innovator Mark Dean in response to a student's inquiries about the origins of the personal computer at any point in a semester. Implementing cultural education practices by inserting education into culture can have a lasting positive effect on the enthusiasm and interest in STEM for every student exposed to this education practice.

The educational ceiling is highest and the learning outcomes are greatest for students of color and those who identify as female who are exposed to cultural education practices in STEM. Cultural additives like teacher creation of communities of engagement that assist with the academic development of students at home, and the integration of current events that identify with student cultures, produce compounding advantages that allow these students to connect STEM concepts at a faster pace. As a result, teachers are in a position to introduce higher level ideas; and these introductions can lead to young women and minority students selecting a STEM major in college and progressing forward into STEM careers—qualifying them as outliers. As previous literature explicates cultural education practices at large, the qualitative research in this study evaluates the significance of cultural education practices for Black men and women who graduated from a Metro Atlanta high school, and went on to pursue a college degree in STEM from Georgia Tech.

Summary

The onus is on educators to cultivate an environment that prioritizes STEM by

recognizing and rewarding student achievement in these areas. When students feel their classroom experience is enriched, they are more inclined to actively participate in advanced math and science courses and eventually pursue a STEM degree (Young, Young, & Paufler, 2017). Culturally sustaining pedagogy calls upon teachers to cultivate a family type of atmosphere hosting a community of learners that engage with the teacher and one another. The creation of this environment can have a force multiplying effect as teachers centralize the needs and interests of students and encourage them to achieve their career goals while pursuing their passions. Furthermore, the academic success, cultural confidence, and critical consciousness of students is perpetuated and fostered when teachers establish a good relationship with the parents of these students and engage with them in positive and productive ways (King, 2017, p. 7).

Because science, education, and the contextual factors that define individual students are always evolving, no singular teacher will be an expert in all relevant domains. When assessing teachers' years of experience as a function of quality STEM education, exclusively focusing on time in the classroom can negligently discount the spectrum of strengths and needs of teachers. However, these points of emphasis are contextually applicable and resourceful on occasion (National Academies of Sciences, 2015c, p. 94). Obviously, second-year teachers are generally more successful than first-year teachers and third-year teachers are more seasoned and effective than second-year teachers (National Academies of Sciences, 2015b, p. 77; Wilson, 2009, p. 4).

In summary, school culture, high quality teachers, access to resources, quality STEM pedagogy, and STEM advocacy, combined, help to maximize STEM outcomes of students and propel them to greater success in STEM as they progress through their education. While other literature evaluates STEM education as a function of these components in general and at other sites, the research in this dissertation reviews these factors at Metro Atlanta high schools for

Black students who matriculate at Georgia Institute of Technology and major in a STEM field.

The next chapter outlines the study's design, methods, data analysis, and limitations.

CHAPTER 3

METHODOLOGY

Research Design

The purpose of this study was to examine the individual factors that promote high attainment for Black men and women in STEM beyond high school, assess high achievement and representation of Black high school students in STEM, and explore mechanisms and resources enabling school success in STEM. The researcher focused on an urban metropolis that is largely inhabited by African Americans and features a prominent STEM-oriented university located in the center of the municipality. The STEM university, Georgia Institute of Technology, claimed the fifth ranked Computer Science program in the U.S. in 2020 (Georgia Institute of Technology, 2021). This study was guided by the following research questions:

1. What are enablers of persistence and success for Black students and alumni of Metro Atlanta high schools who major in a STEM field at Georgia Institute of Technology?
2. What were the extent and variations of representation and achievement in STEM for Black students in Metro Atlanta high schools?
3. What were the extent and variations of disparities within both representation and achievement?
4. What do administrators and teachers identify as successful mechanisms that facilitate quality STEM education in Metro Atlanta schools for Black students in grades 9 through 12?

This chapter highlights the research methodology used in the study. It includes the following sections: research design, theoretical framework, research methods, sample selection,

data collection and analysis, and limitations of the study. This study includes three primary data sources: (1) interviews of Black STEM Georgia Tech students and alumni, (2) administrative data on STEM access and test scores in a metropolitan area, and (3) interviews of K-12 school leaders in STEM in a local major urban school system (see Figure 1).

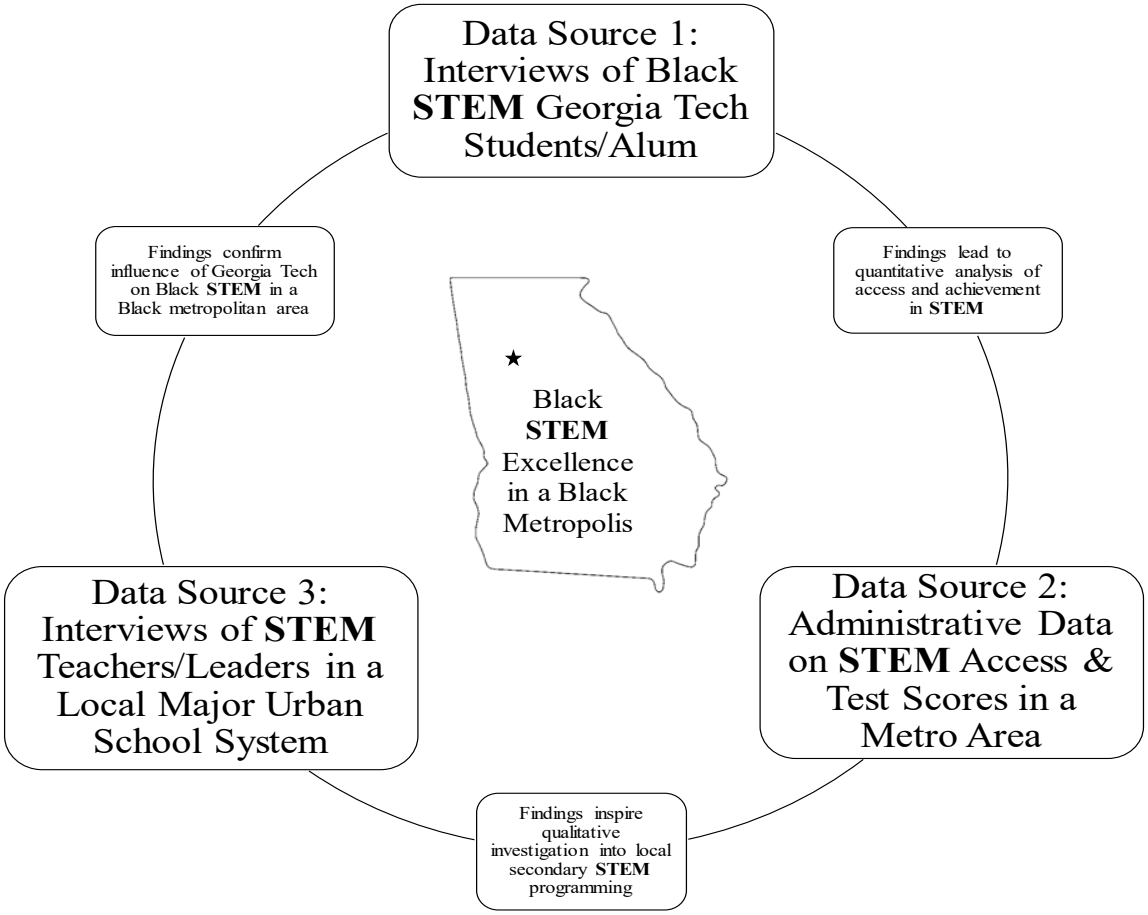

Figure 1. Black STEM Excellence in a Black Metropolis Data Sources

Theoretical Framework

The *anti-deficit achievement* framework is most suitable for this study as it amalgamates eight concepts from psychology, sociology, and education to examine the phenomenon of success for Black students in STEM. The first concept, *cultural capital and social capital theories*, places an anti-deficit focus on comprehending how high achieving minority students

overcame socioeconomic obstacles that confronted them. The second concept, *stereotype threat theory*, studies how Black students productively respond to misconceptions and negative stereotypes in their STEM classrooms and on campus. The third concept, *attribution theory*, is an active invitation for underserved high achieving groups to give their testimony—listing the people, resources and experiences to which they attribute their STEM success. For the achievers, this method opposes the practice of continually listing all of their barriers to success. The fourth concept, *campus ecology theories*, accentuates how Black men and women navigate their educational landscapes and ultimately thrive in STEM environments that are predominately male or White. The fifth concept, *self-efficacy theory*, places an anti-deficit concentration on comprehending how high achieving minority students developed their confidence in STEM-related tasks. Instead of reminding Black students of their historical subjugation, the sixth concept, *critical race theory*, empowers these students to challenge gender, racial, and intersectional narratives that play a role in the disenfranchisement of the subgroups they identify with. The seventh concept, *theories on college student retention*, investigates the factors that keep historically marginalized subgroups on STEM tracks in high school and enrolled in STEM programs through degree attainment. This practice is employed in lieu of focusing on student barriers to perseverance and persistence in STEM fields. The eighth concept, *possible selves theory*, highlights the encouraging experiences of Black students as they envision themselves performing in STEM careers beyond formal schooling (Harper, 2010).

Most policy reports and published literature on students of color in STEM are based on salient yet monotonous inquiries into their struggles or lack of opportunities. Without question, this empirical research is critical to narrowing opportunity and achievement gaps in STEM (p. 64); but by analyzing these students through an *anti-deficit achievement* conceptual framework,

we can amplify their academic accomplishments and their prosperous journeys to navigate predominantly White, male spaces. The focus will remain on success, not failure, as outliers are qualitatively analyzed (Harper, 2010). These outliers achieved by developing confidence in STEM subjects and overcoming discouraging racial and gender misconceptions.

Instead of investigating the unwelcoming environments experienced by Black students in college, the protocol in this study queries how and whether their aspirations to choose a STEM major were influenced by a family member or school leader early in their STEM journey. Rather than asking the deficit-oriented question, "Why are the grade point averages of Black women in STEM lower than their White male contemporaries?" the question is reframed as such: What resources proved most effective in sustaining your academic excellence, cultural competence, and critical consciousness needed to be a key participant in a democratic society? The aim is to intellectualize the bedrocks of influential persons and systems and structures that provided positive experiences for high achieving Black males and females who rose above disadvantage and low expectations.

Research Methods

This study qualitatively applies the *anti-deficit achievement* conceptual framework to highlight the influential persons, pedagogy, school organization, and programs that enable persistence and high academic achievement for Black students who graduate from Metro Atlanta high schools and go on to pursue college degrees in STEM from Georgia Tech. Harper (2010) creatively discovered this framework as way to highlight success in STEM, instead of failure, for traditionally marginalized groups by asking anti-deficit protocol questions as opposed to deficit-oriented questions. Likewise, this study implements the anti-deficit achievement conceptual framework to examine administrator and teacher perceptions of successful STEM programming in a local major urban school system with inquiry into the following: school resources, systems,

and structures that promote the success of Black students in STEM; school and teacher accountability, responsibility, and expectations; teacher recruitment and retention; and teacher expertise and pedagogical practices. For the quantitative portion of this study, Georgia student level data was gathered and inspected for trends over consecutive years.

Based on the large-scale classroom experiment involving emotion regulation interventions by Rozek and colleagues (2019), we know that Black students are predisposed to poor performance in STEM courses due to lower-quality schools devoid of resources. Alternatively, we don't have enough evidence-based research that elevates the voices of successful Black men and women in STEM. This is why it's important to undergo qualitative investigations of enablers of STEM success for Black males and females using the anti-deficit achievement framework, whereby protocol questions are retooled. Table 2 is a sample of commonly examined protocol questions that the researcher reframed to focus on the achievement of the participants of this study using this framework.

Table 2. Sample Reframed Protocol Questions for Interview Participants

Deficit-Oriented Questions	Anti-Deficit Reframing
Why do Black students continue to fall from the STEM educational pipeline?	Which family members were a major influence on your early persistence and success in STEM?
Why are dropout rates and graduation rates disproportionately high and low, respectively, for schools serving predominantly Black students?	How did school culture and expectations influence your interest and high academic achievement in STEM?
Why are Black students disproportionately taught by under-qualified teachers of STEM?	How did teacher expectations encourage and promote your success in STEM?
Why do Black students have a lower pass rate on science and mathematics Advanced Placement examinations than their White and Asian counterparts?	How do personal and school accountability play a role in the STEM engagement and development of Black students?
Why are schools serving mostly Black students consistently under-resourced?	Are there any school resources that facilitate in engaging Black students in STEM?

Sample Selection

Subjectivity/Reflexivity Statement

As an eight-year employee of Georgia Tech Research Institute (GTRI), the researcher has long-standing relationships with members of the university student body, which influenced his decision to use Georgia Institute of Technology to gather data samples for this study. This prestigious STEM institution was also chosen as the research site because it is widely recognized as the leading public university for technologically-focused education and research in the Deep South. Located in the heart of Atlanta, Georgia, this postsecondary school allows the researcher to keep the research site of this study geographically consistent with other phases and data sources of the study, which are focused on Metro Atlanta secondary schools where student

population, educational levels, and socioeconomic levels are diverse.

The researcher is a Black male with a Bachelor's of Science in Financial Mathematics. As a military dependent, growing up in Fort Walton Beach, Florida, his enthusiasm for numbers was limitless. He went on to take advanced math and math-based science courses such as Physics for his entire academic tenure in high school. As a senior at Fort Walton Beach High School, he enrolled and completed the first AP Calculus BC course to be offered in the school district.

Prior to working at GTRI, the researcher was employed by the Boeing Company, where diversity was staunchly emphasized during his five years of employment with the company. The Finance Department consisted of 40 individuals where he was the only African American. Upper management went to extremes to make him feel welcome and comfortable, so much that it made him uncomfortable oftentimes. As a result of his personal encounter while working for Boeing, he is now inclined to collect data by interviewing minorities who have experienced environments where they are one of very few people of color—particularly in STEM environments.

Because of the researcher's academic background and affection for STEM, combined with being Black, he is aware of his implicit preconceptions as it pertains to Black STEM achievement. Furthermore, he is aware that Black interview participants with STEM backgrounds have an increased likelihood of opening up conversationally and articulating their experiences based on the cultural and educational connections they share with the researcher. Other non-Black researchers, or those without STEM backgrounds, might be limited in the extent of data they collect from this particular subgroup of interview participants.

Georgia Tech Participants

For the first phase of the study, 16 semi-structured interviews were conducted with eight Black women and eight Black men. All participants graduated from a Metro Atlanta high school

and went on to pursue a college degree in STEM from Georgia Tech. Ten of the 16 participants earned or are working toward an engineering degree from Georgia Tech (see Table 3). Table 4 lists the high schools attended by the participants and the districts their schools reside.

Table 3. Georgia Tech Students and Alumni Majors or Degrees

Participant	Major or First Engineering Degree at Georgia Tech	Major or First Degree at Geogia Tech (non-Engineering)
Alaika Suffrena	Chemical and Biomolecular Engineering (B.S.)	
Andre Dickens	Chemical Engineering (B.S.)	
Austin Card	Mechanical Engineering (M.S.)	
Bryan Richards	Electrical and Computer Engineering (M.S.)	
Camille Quick	Environmental Engineering (B.S.)	
Isaac Campbell		Computer Science (B.S.)
Jalen McDowell	Mechanical Engineering (B.S.)	
Jamel Thompson	Industrial and Systems Engineering (B.S.)	
Jenelle Wingfield		Architecture (B.S.)
Makayla		Mathematics (B.S.)
Norman Harris II	Aersopace Engineering (B.S.)	
Nyima Piaro		Computer Science (B.S.)
Nicole	Biomedical Engineering (B.S.)	
Sabrina Atwaters	Electrical Engineering (B.S.)	
Tiffany		Computer Science (B.S.)
Victoria		Industrial Design (B.S.)

Table 4. High Schools of Georgia Tech Students and Alumni

Participant	Atlanta Public Schools	Gwinnett County	Cobb County	DeKalb County	Fulton County	Henry County	Douglas County	Other
Alaika Suffrena						Henry County		
Andre Dickens	Benjamin E. Mays							
Austin Card			Pope					
Bryan Richards								Other
Camille Quick					Westlake			
Isaac Campbell								Other
Jalen McDowell						Henry County		
Jamel Thompson					Westlake			
Jenelle Wingfield	Frederick Douglass							
Makayla					Westlake			
Norman Harris II			KMHS/ Whitefield					
Nyima Piaro		Central Gwinnett						
Nicole							Douglas County	
Sabrina Atwaters	Alonzo A. Crim							
Tiffany				Lakeside				
Victoria						Henry County		

Administrator and Teacher Participants

For this component of the study, seven semi-structured interviews were conducted with six administrators and teachers within a large urban school system and one from a neighboring school district. All participants teach or coordinate STEM programs (see Table 5). Five of the seven participants have held a leadership role in education for at least ten years.

Table 5. Profiles of Teachers and Leaders

Leader	School	STEM Program Title	Total Years in Position	Total Years as a School Leader
School Leader 1	School 1	STEAM Coordinator	5	22
School Leader 2	School 2	STEM Program Specialist	3	12
School Leader 3	School 3	STEM Coordinator	5	8
School Leader 4	School 4	Signature STEM Instructional Coach	5	15
School Leader 5	School 1	Computer Science, Music Technology, and Mathematics teacher	3	9
School Leader 6	School 5	STEM Program Specialist	4	11
School Leader 7	School 6	Director of STEM Magnet school	4	14

Data Collection and Analysis

Qualitative data collection and analysis was performed first, followed by a quantitative descriptive analysis to contextualize the preceding qualititative findings. Lastly, a stand-alone qualitative investigation into a local major school system was completed. Prior to data collection, UGA IRB approval was obtained. From there, participants were recruited and asked to sign a consent form prior to being interviewed (see appendix A).

Data Sources

Data Source 1: Qualitative Data. This study surveys insights from Black students who

are currently enrolled at Georgia Tech or have alumni status. Guided interviews of these affiliates of Georgia Tech lasted between 45 minutes and one hour. The interview protocol focused on: (1) support systems, influential family members, and influential school leaders; (2) experience with cultural education practices and hands-on project-based learning; (3) school culture and school and teacher expectations; (4) standardized testing; and (5) participation in college readiness programs. An interview guide was developed specifically for this phase of the study (see appendix B). Interviews were audio-recorded and transcribed; and for the participants who wished to remain anonymous, some identifying information was removed and replaced with a pseudonym. The researcher maintains a master list aligning pseudonyms and identifying names.

Data Source 2: Quantitative Data. Following the qualitative phase of the study, a quantitative descriptive analysis was completed. This phase utilizes Georgia student level data collected from the Governor's Office of Student Achievement (GOSA). The database includes a broad range of information about student-level academic achievement, school characteristics, and postsecondary enrollment data. This phase focuses on specific datasets from GOSA, including Georgia Milestones end-of-course (EOC) comprehensive and summative assessments that measure the knowledge base of students beginning in third grade through high school in a variety of subject areas. These assessments began in the 2014-15 academic year. Other datasets analyzed in this study—provided by GOSA—include Advanced Placement (AP) scores, K-12 enrollment, and postsecondary enrollment data.

Data Source 3: Qualitative Data. Next, a distinct assessment of a large urban school system was completed. Within this examination, the school system—located in Metro Atlanta—was audited to evaluate its promotion and implementation of components of quality STEM

education for Black students. Six educators and leaders within this school system volunteered to participate in loosely-structured interviews that lasted between 45 minutes and one hour. An additional educator from a neighboring school district was also interviewed. The interview protocol focused on: (1) school and teacher accountability, responsibility, and expectations; (2) school resources, systems, and structures that promote the success of Black students in STEM; (3) teacher recruitment and retention; and (4) teacher expertise and pedagogical practices. An interview guide was developed specifically for this assessment (see appendix B). Interviews were audio-recorded and transcribed; and all identifying information was removed and replaced with a pseudonym. The researcher maintains a master list aligning pseudonyms and identifying names.

Data Analysis

Data analysis began during the process of collecting qualitative data. While interviewing the participants, the researcher journalized participant responses. Additional notes were taken during the interview transcription process. During the transcription process, the researcher created and sorted codes into categories. Patterns from interview responses were identified and analyzed, resulting in major themes being developed from the data.

For the quantitative phase, Georgia student level data was gathered and inspected for trends over consecutive years. Secondary and postsecondary enrollment data was disaggregated and analyzed over five- and three-year periods, respectively, by race and gender. Advanced Placement (AP) data was not disaggregated by race or gender. Instead, the focus remained on the number of testers and student pass rates on AP exams. Biology, Calculus, Chemistry, Computer Science, and Physics were the AP courses used in this analysis.

Finally, end-of-course (EOC) scores were evaluated in math and science subjects to

determine the percentage of Black students and White students who performed at distinguished levels relative to the total amount of Black students and White students, respectively, who tested in math or science. Achievement gaps were subsequently calculated by taking the difference between the percent of Black distinguished performing students and White distinguished performing students. The math and science subjects used for this data include Algebra I, Analytic Geometry, Biology, Coordinate Algebra, Geometry, and Physical Science. Middle schools and most charter schools are not included in the data, and only schools where Black students were tested are included. Attempts were made to only include traditional public schools for the purpose of evaluating uniform curricula established by the state board of education.

Limitations

This study has multiple limitations. First, primarily due to COVID-19, other urban and suburban school systems were unable to partake in this study as teachers and administrators from these districts were overwhelmed with continual instructional disruptions. Other school districts with differing student body compositions may have observed different academic outcomes and achievement disparities. Furthermore, districts with students from higher socioeconomic backgrounds may have varying levels of access to resources to support STEM attainment and prevent attrition from students and highly qualified teachers.

Another limitation includes high school students not being interviewed and considered as a data source. It's possible that their perspectives on accountability and expectations, school and community resources, and pedagogical practices may have influenced implications and conclusions of this study. The next chapter, Chapter 4, presents findings of this study from thematic and quantitative data analysis.

CHAPTER 4

FINDINGS

The purpose of this case study was to survey the insights of Black students and alumni from Georgia Institute of Technology who currently major, or received a degree, in a STEM field and who attended high school in Metro Atlanta. The researcher subsequently completed a quantitative descriptive exploration of the extent and variations of representation and achievement in STEM for Black students within Metro Atlanta school districts. Following this investigation, an examination of the perceptions of administrators and teachers in STEM from a large urban school district in Atlanta, Georgia was complete. This study was guided by the following research questions:

1. What are enablers of persistence and success for Black students and alumni of Metro Atlanta high schools who major in a STEM field at Georgia Institute of Technology?
2. What were the extent and variations of representation and achievement in STEM for Black students in Metro Atlanta high schools?
3. What were the extent and variations of disparities within both representation and achievement?
4. What do administrators and teachers identify as successful mechanisms that facilitate quality STEM education in Metro Atlanta schools for Black students in grades 9 through 12?

This chapter presents findings from the study. The chapter begins with the context of the

study, and it includes Black Georgia Tech alum and student portraitures. The next section presents findings that outline the insights of these affiliates of Georgia Tech using the following major themes: STEM advocacy, pedagogy, school organization, standardized testing, college readiness or related programming, and the Black experience at Georgia Tech. The section that follows present a quantitative descriptive analysis of the seven school districts where the Georgia Tech participants of this study attended high school. Finally, an examination of a large urban school system, whereby the perceptions of teachers and administrators were analyzed, is included. The following major themes are outlined in this section: accountability, school and community mechanisms, recruitment and retention, and pedagogical practices.

Context of the Study

The primary participants in this study are Black alumni and students from Georgia Tech—the most preeminent STEM intuition in the Deep South—who currently major or received a degree in a STEM field and who attended high school in Metro Atlanta. These 16 participants attended high school across seven school districts in Metro Atlanta and either earned or are working toward their first degree from Georgia Tech in engineering, computer science, mathematics, or technology design. Following this qualitative study, a quantitative descriptive analysis was completed. This analysis evaluated the extent and variations of representation and achievement in STEM for Black students within the seven Metro Atlanta school districts attended by the 16 participants in this study. From there, high school leaders from a large urban school district in Atlanta—a metropolitan area in the former Confederate States of America—were interviewed to examine their perceptions of successful STEM programs.

This study avoids focusing on why Black students are underprepared for college-level math and science courses, but instead it focuses on major components of support systems that support student matriculation in STEM programs. Instead of answering research questions about

how few Black STEM graduates continue on to graduate school, this study queries the culture and expectations of high schools and their influence on interest and high academic achievement for Black students in STEM. At large, this study investigates Black men and women from Atlanta, Georgia, who have successfully navigated through the STEM educational pipeline to Georgia Tech and into their careers.

Instead of simply completing thematic analyses and creating tables that outline the K-20 STEM experience—for the 16 participants of this study who are affiliated with Georgia Tech—it was important for the researcher to elevate the individuality of each participant with a summary of their story of academic success in science or math. Their experiential perspectives are immeasurably important to understanding how African American students, as outliers, succeed in STEM while growing up in Atlanta, Georgia, and ultimately enrolling in the leading STEM institution in Atlanta and in the South. Their high academic achievement is a function of aberrant success and not traditional or historical patterns. Because of this fact, it's imperative that their stories are highlighted and made available for public consumption.

Data Source 1A: Black Georgia Tech Alumni

These ten Black men and women have earned degrees from Georgia Institute of Technology. The subheadings in this section ascribe each participant's first accomplished degree from Georgia Tech. The names of some participants have been assigned pseudonyms to protect their identity. Others have consented to using their true names for this study.

Isaac Campbell, B.S. Computer Science

Dr. Isaac Campbell [pseudonym] is a graduate of a predominantly Black high school in a large urban school district in Atlanta, Georgia. Upon completion of high school, Isaac enrolled at Georgia Tech where he earned a four-year degree in Information and Computer Science prior to

the College of Computing at Georgia Tech being recognized as the first of its kind at any public postsecondary institution in the nation (History of GT Computing, 2020). Dr. Campbell would go on to achieve an M.S. and Ph.D. in Computer Science from another elite STEM intuition in the Northeast.

Young Isaac knew he wanted to be a computer scientist as early as age eight, even without depth of knowledge of what the occupation entailed. Moreover, before reaching high school, he knew he wanted to be a professor. Together, these two self-fulfilling prophecies created a metaphorical chemical response that freed up reactions to make the whole greater than the sum of their individual parts. Through it all, his mother maintained a keen ability to convince he and his siblings that academic excellence was unavoidable and attending college was inevitable with no alternative.

Isaac grew up in Atlanta during a tumultuous, uncomfortable, and even unsafe time, particularly for people within the Black community. In his middle school, a male student was reported as missing with his disappearance being attributed to Atlanta's Missing and Murdered Children, as it was titled during the perilous time from 1979 to 1981. In seventh grade, Isaac experienced his most impactful teacher who purchased an eighth grade Algebra textbook out of his own pocket in an effort to maximize Isaac' mathematical capabilities. As of the date of this study, Isaac remains in contact with this teacher who also linked him with the Duke University Talent Identification Program (TIP). The program provided an opportunity for Isaac to take the SAT years before his official score would be used for his lone undergraduate college application to Georgia Tech.

Prior to beginning eighth grade, Isaac participated in a summer science program where he and his peers built a telescope. The following summer, they built a computer. These experiences

were his first formal introductions to STEM. After reaching high school, Isaac tested and applied for admission into the school's science and math academy. After being accepted, he completed five AP courses, most notably Calculus, Chemistry, and Computer Science, the latter of which he completed as the only student in the academy to attend the course.

In high school, Isaac was surrounded by distinguished company, both realized and unrealized. He shared classrooms with future city politicians of Atlanta and the children of preeminent politicians in office at that time. While Dr. Campbell did not participate in any college readiness or related programs, he firmly believes that the science and math academy within his high school prepared he and his peers for college and even helped him earn a scholarship at Georgia Tech.

Isaac felt the happiness of others who were proud of any academic success he achieved. In fact, he fondly gloats about the illusion that many Black folks experienced in Atlanta in believing they were among the majority considering the relative successes they encountered and that their mayor was Black and interwoven into the fabric of their everyday society. However, his personal perceptions dramatically changed when he first strolled the campus of Georgia Tech as a wide-eyed first year student. He was instantaneously overwhelmed by massive culture shock when he could not locate another fellow African American as he walked from one building to the next. He felt alone. Yes, the Atlanta University Center (AUC) had an established partnership with Georgia Tech for dual degrees for Black students coming from Morehouse College, Spelman College, and Clarke Atlanta University (Dual Degree Options, n.d.). However, the program was specific to engineering students, and Isaac was an ambitious Computer Science major. He was deprived of the support structure provided by Black consortiums such as the National Society of Black Engineers (NSBE) during his undergraduate studies. Nevertheless,

Isaac was undeterred by these cultural community hurdles in his pursuit of advanced education in computer science; and he attributes his unflinching determination to the robust foundation and support network provided by his family and his educational journey to that point in his life.

Sybrina Atwaters, B.S. Electrical Engineering, 1994

Dr. Sybrina Atwaters is a 1989 graduate of the former Joseph Charles Murphy High School, which eventually became Alonzo A. Crim High School prior to her senior year. Named in honor of the first Black superintendent of Atlanta Public Schools (APS), Crim High School is now an alternative school for non-traditional students. Dr. Alonzo A. Crim retired from his post in 1988 after 16 years, and he later became a mentor for Dr. Atwaters. He played an integral role in her success, leading financial support strategies that allowed her STEM pursuits.

In 1987, the Georgia Tech Chapter of NSBE visited Sybrina's high school and spoke to her advanced math class. This was her first introduction to a STEM organization, and it imbued an impression that would sustain Sybrina beyond this moment in perpetuity. She would go to earn her B.S. in Electrical Engineering in 1994 from the very institution that portrayed Black excellence in engineering to a teenage Sybrina. In sum, she has amassed five degrees with three being awarded by Georgia Tech.

Grade school came easy for Sybrina, and she even enjoyed standardized testing days as she consistently finished early and was allowed to leave the classroom in a responsibly independent manner. As an enrollee in predominantly Black schools in APS, she experienced a great deal of culturally relevant, responsive, and sustaining pedagogies. According to Sybrina, teachers and administrators of these schools industriously invested in students, not allowing their socioeconomic circumstances and conditions to define them.

In contrast, during her time as a student at Georgia Tech, Sybrina faced the reality that

failure was common; and as a result, she had many crying nights. The rigor of coursework combined with the absence of cultural education practices that she was exposed to during her academic journey oftentimes overwhelmed her intellectually, but quitting was not an option. This was especially the case during her first year on campus. However, after later encountering her first Black professor within her Electrical Engineering major—Dr. Gary May, former dean of College of Engineering at Georgia Tech—she grew comfortable with the challenging content within her program as she navigated the demanding academic landscape. Dr. May imparted educational knowledge through both lecture and mentorship in a way that connected with Sybrina, enabling her to reach the finish line of her degree and thrive in graduate school. Oddly, as a Black graduate student at Georgia Tech, Sybrina did not encounter an increase in difficultly in coursework. Conversely, she did experience an increase in isolationism and a decrease in cultural and communal atmosphere.

Dr. Atwaters is presently the Director of the Office of Minority Educational Development (OMED), a noteworthy organization at Georgia Tech that specializes in providing rich resources and educational services to traditionally underrepresented students. Her academic journey did not directly cultivate this professional outcome. Alternatively, as an intersectional intellectual keenly aware of diversity, equity, and inclusion and social injustices that exist even in education, she enthusiastically immersed herself in minority education and development as a parallel path for her insanity. This organization that she astutely and joyfully shepherds is known for creating a home for historically underserved students who frequently feel isolated at predominantly White institutions. Most of the interviewees in this study credit this program for their corresponding matriculation and academic persistence at Georgia Tech.

Andre Dickens, B.S. Chemical Engineering, 1998

A graduate of Benjamin E. Mays High School of APS in 1992, Andre Dickens' academic journey to Georgia Tech is of a unique variety, but likely not dissimilar from other Black inner-city youth of his time across the nation in metropolitan areas. Andre's earliest recollection of his STEM introduction was at age five, where he was attracted to Legos, enabling him to precociously engage in components of structural, mechanical, and civil engineering. At age eight, he received a chemistry set for Christmas from his mother and instantly fell in love with the experiments that this science tool provided. They helped shape his path to ultimately earn a B.S. in Chemical Engineering from Georgia Tech in 1998.

Mr. Dickens experienced his only White teachers throughout his schooling while in Kindergarten, first and second grade, having been taught by the same teacher for the latter two years. He glowingly raves about his third grade teacher, Mrs. McDaniels, an attractive Black woman in her late 30s who dissolved any monotony he and his male peers felt while attending school daily. Her charming presence broadly inspired discipline and excitement for her Black male students to adhere to her instruction. This is Andre's earliest memory of being taught by a teacher with a physical appearance and nurturing tone that resembled his mother—the most influential person in his life. After witnessing the collegiate, congenial competition among the Black boys in her class, as they challenged one another with their multiplication tables, Mrs. McDaniels upped the ante among the group of cooperatively competitive young men by increasing the rigor of math questions. She leaned into their academic curiosities by stimulating their brains and pushing their ceilings.

As an excelling fifth grader in Metro Atlanta's elementary school pull-out program titled Target for gifted students, Andre's teacher immediately recognized his potential. As a result, she

encouraged his mother to enroll him into the nearby newly established Southwest Middle School for his sixth and seventh grade years as opposed to the traditional route of attending elementary school through seventh grade and then beginning high school the following year. During the enrollment process, Andre was required to take an entrance exam, whereby he scored exceptionally well on the math portion. Accordingly, he was placed on an advanced track in math in preparation for schooling at the secondary level, eventually leading to this acceptance into the Benjamin E. Mays High School Science and Mathematics Magnet Program.

Originally aspiring to become a professional baseball player during his formative teenage years, Mr. Dickens joined the Mays High School Quiz Bowl team as an alternate in the eleventh grade. During a competition in the Spring of 1991, over a three weekend period, the team experienced massive success as they defeated predominantly White high school teams, similarly predominantly Black teams, and others in route to the championship bout. The semifinals and championship were held on the campus of Georgia Tech in what would be Andre's first trip to the premier STEM-influenced institution—established as the second ranked Chemical Engineering program in the U.S. in 2020 by U.S. News and World Report (Georgia Institute of Technology, 2021).

While his high school resided just 13 miles from Georgia Tech, Andre was unaware of the university's precise location in his hometown of Atlanta. Although his team suffered defeat in the championship match of the Quiz Bowl competition, Andre and his teammates were surreptitiously being scouted by Georgia Tech admissions recruiter, Keith Jordan, who witnessed the group's high scholastic aptitudes. Mr. Jordan invited Andre and his friends to attend Minorities Interested in Technology and Engineering (MITE)—a weeklong summer program for high school students on the campus of Georgia Tech—and Andre and his family made provision

for him to attend. This program simulated large university lecture halls and provided introductions for aspiring STEM students to Georgia Tech faculty. On the final day of MITE, Keith Jordan reconnected with Andre and noted his energetic participation and achievement throughout the week as well as Andre's high GPA and acceptable SAT score. From there, he offered Andre an opportunity to attend Georgia Tech as a first year student in the Fall of 1992. Mr. Jordan assured Andre's acceptance into the prominent institution—with the fourth best undergraduate engineering programs in the U.S. in 2020 (Georgia Institute of Technology, 2021)—with the admissions application being a mere formality. Within six weeks of this discussion at the conclusion of Andre's participation in MITE, he received his acceptance letter from Georgia Tech with the bulk of his senior year of high school still to be completed. He never applied for any other colleges.

Andre lauds the power of college readiness or related programs considering just four months prior to his acceptance into Georgia Tech, he had no geographical understanding of where the university was located. But these programs provided him with grand academic opportunity as a young Black man growing up in an urban neighborhood in Atlanta, Georgia. Unquestionably, this auspicious opportunity had to intersect with preparation on the part of Mr. Dickens in order to produce this outstanding fortune for him. His solid foundation can be attributed first to his mother and then to his charismatic third grade teacher, his fifth grade teacher who took notice of his unique mathematical abilities, and his acceptance into the science and math academy at Mays High School. Then, with a stroke of good luck, a Black representative of Georgia Tech who believed in Black recruiting found high school recruits at an academic competition on the university's campus. As a current City of Atlanta council member, Mr. Dickens owes a debt of gratitude to this incredible confluence of fortunate events that took

place early in his STEM journey.

Bryan Richards, M.S. Electrical and Computer Engineering

Dr. Bryan Richards [pseudonym] is a graduate of a predominantly Black high school in a large urban school district in Atlanta, Georgia. Immediately following the completion of high school, he enrolled at a Historically Black College or University, where he would earn his B.S. in Electrical Engineering. From there, he obtained his M.S. and Ph.D. in Electrical and Computer Engineering from Georgia Tech. It's apparent that Bryan had an educational plan and pathway to excellence from early on that he executed with pristine precision.

Though an average grade school student by his own admission, Bryan credits the advent of technology in the form of video games for piquing his interest in computing as an adolescent. After his grandmother purchased an Atari 2600—a home gaming console sold for $199 USD in 1977 (McKerracher, 2018) —Bryan suddenly became enamored with the computing theory behind the technology. "Man, it would awesome if a person [in the video game] could climb into the tank!" he would animatedly express to himself while playing the game, *Combat*. In elementary school, Bryan would visit his aunt and maternal grandmother, both school teachers, during summers in Winston-Salem, North Carolina. They preemptively checked out Apple II computers from the local library to give him early access to the machines to serve his inquisitive mind. Here, the die was cast, and Bryan would embark on a STEM journey that would culminate with his promotion to a key leadership role at one of the world's renown institutions for science, technology, engineering, and mathematics.

Once he reached high school, it clicked! "It's time to use this brain I've been given," Bryan told himself. His Calculus teacher became extremely instrumental in his academic success, particularly in math. Prior to attending the eighth grade, Bryan underwent math

placement testing and earned a score that would land him in Pre-Algebra as opposed to Algebra I. Unfazed by this assignment, he remained on a standard math track until late in his eleventh grade year when he recognized that his current trajectory would grant him a high school diploma with Pre-Calculus as the highest level math achieved. He then conjured the unconventional thought of synchronously taking Pre-Calculus and Calculus I as a senior, which would eventually propel his STEM progress and produce aberrant success relative to his peers. Completion of non-AP Calculus notwithstanding, Bryan sat for the AP exam at the urging of his teachers and guidance counselors, and he received a passing score.

Young Bryan blossomed in Calculus beyond even his own expectations, while his dear friend struggled to make even a passing grade. Conversely, when it came time to take the SAT, his friend achieved a significantly higher math score, which greatly perplexed Bryan. He later discovered that his friend had been introduced to Kaplan prior to sitting for the SAT, which boosted his knowledge on testing techniques and methods to prepare him. In this way, Bryan and his friend were a case study of access, and lack thereof, to resources that augment academic success. Inversely, Bryan's grandmother and aunt being school teachers afforded him institutional knowledge and accesses early on in his STEM journey that have ultimately catapulted him to an acclaimed role at one of the most prominent intuitions in the South.

Tiffany, B.S. Computer Science, 2001

Tiffany [pseudonym] is the great-great granddaughter of Spencer Bryant, an ecclesiastic sharecropper born in Conyers, Newton County, Georgia—in what is now Rockdale County. Born in 1865, the year of Emancipation, Spencer and his family would eventually relocate and settle in neighboring DeKalb County, a suburb of Atlanta. Because Spencer decided to remain in the South but move northward closer to Atlanta, as oppose to migrating North to an

industrialized urban city during the Great Migration, a butterfly effect followed that would eventually grant his direct descendant an academic opportunity that otherwise might not have been available.

As African Americans in the Deep South navigated the post-Civil War era, White supremacy became rampant and pervasive with the departure of Union troops from southern municipalities as part of the Compromise of 1877. This was a treacherous and turbulent time for Blacks given Jim Crow, prevalence of lynchings, and scarce economic opportunity within the sharecropping system below the Mason-Dixon line. However, Spencer and his son Moses—Tiffany's great grandfather—kept their heads down and stayed the course, plowing and tilling their land daily.

Understanding the value of hard work and capital, Tiffany's dad—the paternal grandson of Moses Bryant—directed his full support and accompanying resources toward his academically prodigious daughter. In elementary and middle school, Tiffany excelled at science fairs and Mathcounts. Prior to this, she was recommended by administrators and teachers for DeKalb County School District's (DCSD) pull-out program for the gifted, titled the Discovery. This would eventually lead to an accelerated track in math and science followed by young Tiffany's transfer to an elementary school with a Magnet program.

As a beneficiary of DCSD's racial integration program, titled *Majority-to-Minority*, Tiffany thrived at Lakeside High School. Every math and science course she completed was advanced including her Intro to Computer Science class. This set her up beautifully to graduate from Georgia Tech with a B.S. in Computer Science despite her initial desire to attend NC A&T.

Tiffany's dad, the descendant of a persevering family from suburban Atlanta, entertained her eagerness to leave the state to attend a Historically Black College or University (HBCU), but

he did not capitulate to her dream. Uncooperatively, he comprehended the opportunity that his forebears bestowed upon him to provide for his only daughter, which was to attend the illustrious STEM institution just minutes from where his family farmed for generations pre- and post-slavery. As a result of his stance for his daughter to attend college close to home, Tiffany is an accomplishing Associate Director at Georgia Tech Research Institute, having earned her Master's of Business Administration (MBA) along the way and facilitating career opportunities for other Black individuals with STEM backgrounds. Today, Tiffany feels validated in hers and her dad's final collaborative decision to attend Georgia Tech despite her initial divergent perspective.

Jenelle Wingfield, B.S. Architecture, 2002

Jenelle is a 1998 graduate of Frederick Douglass High School of APS. She achieved her B.S. in Architecture from Georgia Tech in 2002, and has since earned an M.A. and Ed.S. in Secondary Mathematics and Curriculum and Instruction, respectively. In Fall 2020, Black students were the most underrepresented group majoring in Architecture at Georgia Tech with seven percent enrollment compared to 45 percent White, 28 percent Asian, and twelve percent Latinx (Student Enrollment, n.d.). Moreover, Jenelle ~~*she*~~ is a primary positive influence for intellectually gifted students within the International Baccalaureate Diploma Program at Westlake High School in Fulton County, Georgia. Likewise, she served as the STEAM Magnet Coordinator at Westlake from 2013 to 2019, where she taught and mentored numerous students advanced in science and math, to include notable Westlake alumni who were interviewed for this study.

Jenelle's introduction to science and technology took place in elementary school in Oregon as she watched an episode of *The Cosby Show*. In this eighteenth episode of season one,

Vanessa participates in a science fair with a substandard diorama of the solar system while her close friend scrupulously completed an extravagant robotics project. Seeing young Black girls perform in an advanced science environment captivated Jenelle and inspired her STEM mind. Furthermore, as an early prodigy in second grade, her standardized test scores were so high that she was elevated to fourth grade math and reading. Her school petitioned for her progression to the fourth grade altogether. However, her mom's concern for social development disparities between age groups took precedent, and she vetoed the plans for Jenelle's full advancement to fourth grade.

Upon relocating to Atlanta's inner-city, Jenelle and her family instantaneously recognized the relative inferiority of her school district cluster. Accordingly, they sought external forms of higher level engagement and enrolled Jenelle in a space camp sponsored by Georgia Tech in the summer after fourth grade. The prestigious STEM-oriented university was then officially in her educational constellation.

Jenelle affectionately expresses her gratitude for her Geometry teacher, Mrs. Barbara J. Woolfolk, for personal investment and constant encouragement. One day, during her senior year, Mrs. Woolfolk walked into Jenelle's Trigonometry class to speak with the teacher when she immediately noticed Jenelle sitting in the front row. Comprehending the infinite nature of Jenelle's mathematical abilities, Mrs. Woolfolk directed Jenelle to follow her down the hall to the AP Calculus class to galvanize her mind in the highest level math available at Douglass High School. Mrs. Woolfolk surfaced as her greatest supporter and primary advocate for her educational advancement. Jenelle decisively believes that had this occurrence not taken place, leading to Calculus being added to her high school transcript, she likely would not have been admitted into Georgia Tech. She later opportunely returned the favor as the Magnet Coordinator

at Westlake High School where two of Mrs. Woolfolk's grandchildren were prosperous participants under Jenelle's stewardship.

The story of Jenelle's personal journey cannot be told without citing the Woolfolk family. Alternatively, the inverse is true, proven by her mention in Geary Woolfolk's book, *Before the Application: How to Become the Ideal College Candidate*. This book chronicles steps recommended for families to groom their children to become college-ready and succeed at the highest academic levels; and it was written by Barbara J. Woolfolk's son, Geary, who also served as a mentor and big brother to Jenelle during her professional journey beginning in her second year at Westlake High School.

Because her enrollment at Georgia Tech began in the summer following high school graduation, Jenelle was unable to participate in the OMED Challenge program. While she is grateful for her summer experiences and early introduction to campus life at Georgia Tech, she laments this missed opportunity of building camaraderie among fellow minority incoming first-year students and learning how to learn in a low-stakes accountability environment, where outcomes are not determined solely by test scores and credits received. All in all, she overcame lower socioeconomic status, colorism, bullying, and criticism for choosing Georgia Tech over an HBCU during her K-12 experience. Moreover, in her final two years at Georgia Tech, she conquered the challenges of a dreadful daily commute to campus, full-time parenthood, and the compounding responsibilities of working a part-time job as a full-time student. Jenelle demonstrated a preternatural ability to persevere and achieve at a high academic level in STEM.

Austin Card, M.S. Mechanical Engineering, 2017

Austin is a 2012 graduate of Pope High School of Cobb County School District (CCSD). Upon completion of high school, he enrolled at Georgia College & State University where he

earned his B.S. in Physics in 2016. Austin achieved an M.S. in Mechanical Engineering (ME) from Georgia Tech in 2017.

Austin's mom earned an Electrical Engineering degree from the University of South Carolina as a first generation college student. Because of her STEM expertise and experience, she constantly encouraged her two sons to connect with science and technology. In 2008, as Austin was finishing up middle school and preparing for high school, Mrs. Card registered Austin and his younger brother for a week long video gaming course on the campus of Kennesaw State University. During this formative period, Austin was a compulsive gamer; and even though he unenthusiastically attended the course, by its conclusion, he was satisfied with his mother's decision to enroll he and his brother. In addition to this experience, he cites his early penchant for Legos and math and having access to a home computer through his mom's employer, International Business Machines Corporation (IBM), as catalysts to his persistent interest in STEM.

As an Honors Chemistry students at Pope High School during his senior year, Austin was taught by Ms. Williams. Considering the limited possibility of having a Black science teacher, Austin looked forward to attending her class on a daily basis; and he felt more comfortable being himself in her class given the cultural connection they shared. Then at the end of the school year, unbeknownst to Austin, he was a nominee and recipient of a science award due to his academic excellence in Ms. Williams' Chemistry Honors class.

When it came time to declare a major, Austin gravitated toward the science-based field that required less memorization but involved math and corresponding application. He initially intended to major in ME at Georgia College after recognizing that he would not be a member of the school's men's varsity basketball team as he originally had planned. However, because the

university did not offer this major, he selected the correlated field of Physics. While completing his undergraduate studies, Physics Professor Hauke Busch encouraged Austin to take advantage of a partnership created between Georgia College and Georgia Tech, whereby recipients of undergraduate degrees from Georgia College have a defined pathway to complete a graduate degree from Georgia Tech.

While he did learn to code during his graduate level mechanical engineering studies at Georgia Tech, the work required in this area was limited. Nonetheless, the non-technical skillset, to include the cultivation of his tireless work ethic—combined with his software engineering internship that he completed while attending Georgia College as an undergraduate—have placed him in position to firmly grasp software coding at a rapid pace. This endeavor has proven to be a meaningful investment into his human capital.

Austin possesses a profound perspective of his parents' college degrees narrowing racial opportunity and wealth gaps relative to other Black families in America. Because his parents are college-educated, they were able to land good jobs upon completion of their degrees. They eventually moved to East Cobb, Georgia, where Austin and his younger brother attended Pope High School. He declares that the advanced STEM coursework completed at Pope High School enhanced his ability to succeed academically in college; and as a result, he is currently an accomplished Software Engineer for the pioneering technology corporation, Microsoft.

Norman Harris II, B.S. Aerospace Engineering, 2019

Norman Harris grew up in Cobb County, Georgia, where he began his secondary education at Kennesaw Mountain High School of CCSD. He performed remarkably well in their Mathematics, Science, and Technology Academy before transferring to Whitefield Academy to enhance his prospect of gaining admission into a top college or university. He graduated in 2015

and immediately began his postsecondary educational journey at Georgia Tech where he earned his B.S. in Aerospace Engineering (AE) in 2019.

Before Norman was recognized as gifted in elementary school, and subsequently placed in Metro Atlanta's pull-out program titled *Target*, he demonstrated mathematical exceptionalism, evidenced by the higher-order concepts introduced to him by his mom. Norman comes from a noble math pedigree with his mom earning her Master's of Science in Mathematics from Fisk University. Because of her intellectual prowess and academic exploits, she had exclusive insight into the value of requiring her son to recite his multiplication tables at an advanced age before his classmates had even breached the surface of math beyond addition and subtraction. This fostered his affection for math. As a participant in Target, Norman engaged in advanced math and science curriculum in partnership with the local middle school, to include a robotics projects and corresponding computer programming. This cultivated his interests in science.

Both of Norman's parents worked for IBM, and have since retired from the tech giant. As consummate employees, when they upgraded their personal computers, they were permitted to keep their old ones; and they gifted them to Norman. Instantly, a seed was planted. This access to computers earlier than his peers refined his aspirations to become an engineer.

At Whitefield Academy, Norman's head basketball coach, Tyrone Johnson, was a Black man who also served as the dean of students. Because Coach Johnson carried these dual roles, he came to know the members of the basketball team not only as athletes, but also as burgeoning scholars. Although Norman did not have clarity at the time, he now comprehends the significance of being coached and mentored with an infusion of personal accountability. Coupled with society's broad misconceptions of the Black athlete, these teaching tactics by Coach Johnson prepared Norman for the challenging road ahead. As a standout walk-on on the Georgia

Tech men's varsity basketball team, Norman faced firsthand encounters of being labeled and marginalized in the classroom by his professors and academic counterparts. Despite unjust characterizations of anomalous Black student athletes majoring in engineering, Norman audaciously thrived academically and athletically. He refused to allow his unique duality to become an impediment to his success.

Norman's oldest sister has earned her Jurist Doctorate, and his next oldest sister is an accomplished journalist. Moreover, his sister closest to him in age has achieved her Doctorate in Medicine with a specialization in Ear, Nose, and Throat (ENT). With three older siblings who pushed the limits academically, Norman channeled the pressure to perform at a comparatively high level; and this pressure to bear their standard powered him to persevere even when faced with what seemed like overwhelming challenges as an AE major. He reflectively recalls his first week of college in the *Introduction to Aerospace Engineering* course where he and his partner began working on a collaborative assignment on Monday. By Wednesday, his project partner and friend had dropped the class and changed her major altogether. Upon hearing the news, Norman immediately began to question his own determination to endure the academic difficulties that accompany the AE curricula at Georgia Tech.

Midway through his third year, Norman was granted the opportunity to conduct research with Dr. Mitchell Walker—one of two Black research professors in the AE department as of the date of this study. During this developmental time, Norman gained valuable field experience through experimentation and the scientific method. This apprenticeship spoke to Norman, providing an introspective and profound glimpse into the rewarding career of an Aerospace Engineer as he applied his acquired textbook knowledge in a hands-on environment. Largely due to this involvement, he is now a Propulsion Engineer at the Boeing Company. Furthermore, he

recently completed his first year of graduate school at the University of Southern California, working toward his Master's of Science in Computer Science.

Nyima Piaro, B.S. Computer Science, 2020

Nyima Piaro graduated from Georgia Tech in May 2020 with a B.S. in Computer Science. Before his time at Georgia Tech, he attended Central Gwinnett High School of Gwinnett County Public Schools, where he graduated with honors in 2015. Though born in the U.S., Nyima is the son of Nigerian refugees.

Nyima's dad Ken Piaro was a frontline activist for the *Movement for the Survival of the Ogoni People (MOSOP)*—an organization founded in 1990 by indigenous residents of a southeastern region of Rivers State in Nigeria as a social justice campaign to protect their community from crude oil extraction and petroleum waste dumping (MOSOP and Ogoni News and Resources, 2015). In protest against the environmental destruction caused by the collaboration of the Nigerian government and Royal Dutch Shell—resulting in countless oil spills—nine members of MOSOP were hanged on November 10, 1995 (The Ogoni Nine Execution, 2019). Ken avoided capture after the ordering of his arrest earlier that year, and he was driven underground in hiding for 12 months. He briefly resurfaced to reconnect with his wife and two-year-old daughter in December 1995; and in the still of the night, they fled to neighboring West African country, Benin. They victoriously reached the U.S. Embassy in Benin and requested relocation to anywhere in the United States. With *refugee* status, they had no input into their U.S. destination, but advantageously they were assigned to Atlanta, Georgia, where their flight landed on Valentines' Day of 1996. Nyima was born in October of that year.

Nyima's interests in STEM go back to his early childhood at age five when his dad purchased a telescope for them to observe space constellations. Additionally, Nyima played free

online games at Miniclip's website and watched space shuttle launches with his dad. From there, his fixation on space and computers only grew and evolved.

Nyima credits his Couch Middle School science teacher, Mr. Dennis Turnham for pushing him to be more curious and interact with science. During that time, Nyima was a participant in several extracurricular activities, to include the Chess Club and the school's Quiz Bowl team, both sponsored by Mr. Turnham. This teacher was a strong advocate for Nyima in his STEM journey, even informing him of celebrated colleges and universities to consider for his postsecondary education.

In high school, many of Nyima's science and math teachers had degrees from STEM-focused universities. Accordingly, they engaged him frequently in STEM conversation and influenced him to pursue such track in college. While at Central Gwinnett High School, Nyima completed an engineering basics course that taught him the entire spectrum of engineering. Moreover, he completed several Advanced Placement courses in STEM subjects, to include Biology, Calculus AB, Calculus BC, Physics 1, Physics 2, and Chemistry. While he strongly desired to take AP Computer Science, his school did not offer the course due to a lack of comprehensive interest from the student body.

Nyima is currently a Software Engineer for the Santa Monica, California-based, *BuildOps*, a software development company improving productivity at construction sites. Given the high demand for this technology and his expertise in the field, he was able to secure this job despite completing his degree at Georgia Tech after the onset of COVID-19 and the pandemic's accompanying economic uncertainty. As a recipient of a Computer Science degree with a concentration in Media and People, Nyima fully grasps the magnitude of his education and the endless opportunities that it will provide. However, with conviction, he is confident in his work

ethic and resourcefulness as an autodidact with interests in science and technology going back to his adolescent years. Nyima is abundantly appreciate of his experiences at Georgia Tech, and he would encourage any ambitious computer scientist to follow in his academic footsteps. He is also a devoted advocate of self-educated methods for software savvy entrepreneurs who aspire to work in the field of coding as quick and efficient as possible.

Makayla, B.S. Mathematics, 2020

Makayla [pseudonym] graduated from Georgia Tech in December 2020 with a B.S. in Mathematics. Before her time at the prestigious college, she attended Westlake High School of Fulton County Schools, where she graduated in 2016. Her parents and older sister were born in Sierra Leone, but later moved to the U.S. to escape the country's civil war which began in 1991. Makayla has always loved math as noted by her jubilant expression, "It's fun!" when referencing the subject and its traditionally complex nuance.

The *No Child Left Behind Act of 2001 (NCLB)* commissioned states to adopt annual standardized tests in third grade through eighth in reading and mathematics and at least once in high school between tenth and twelfth grade by the 2005-06 school year (Vinovskis, 2009, p. 173). By 2013-14, all students were expected to meet adequate levels of proficiency (Clarke, 2007, p. 147; Sunderman, 2009, p. 185; Vinovskis, 2009, p. 173). Makayla's dad was determined to guarantee her success on Georgia's Criterion-Referenced Competency Tests (CRCT)—the state's standardized assessment used to measure adequate yearly progress for elementary and middle school students (No Child Left Behind (NCLB), 2019). Therefore, he purchased CRCT books at and above her level in elementary school, and Makayla thoroughly enjoyed completing the math portion inside of each book. She claims these practice test experiences as the impetus of her love for math. The CRCT has since been replaced by the Georgia Milestones Assessment

System (Criterion-Referenced Competency Tests (CRCT), 2021).

Growing up in Cobb County, before later moving to Fulton County, Makayla was recognized as gifted and admitted to the county's pull-out program, *Target*. Her gifted teacher was instrumental in fostering her enthusiasm for education to the point where she did not observe her precocious mathematical acumen until she began her studies at Georgia Tech. After receiving her acceptance letter, she was offered admission into *Challenge*—Georgia Tech's signature program within the Office of Minority Educational Development (OMED)—for incoming first-year students. It was here where she was mentored by a Black woman who also attended Westlake High School who happened to major in Mathematics at Georgia Tech. This served as an inspiration to Makayla, instilling belief that a degree in this particular field at this institution was possible.

During her pursuit of her Mathematics degree, she began tutoring members of the university's football team. Initially, at the beginning of this process, she was less successful at reaching this intelligent yet athletic subgroup of campus who were not as familiar with higher level math as Makayla. Then, with the implementation of culturally relevant pedagogy on her behalf, she was able to connect advanced mathematical concepts to this largely Black sector of the university's student body. She felt as though she was their translator; and one particular example that resonates with her memory is how she taught these student athletes the trigonometric concept of the *unit circle* being on the inside of their hand.

Ironically, as a tall Black woman at Georgia Tech, Makayla found herself expatriated by her non-Black classmates. She was commonly mistaken as a student-athlete and thusly negatively stereotyped. When group work was necessary to complete assignments, she often struggled to find a partner who would take her work ethic seriously. In some instances, her peers

would immediately begin speaking in their native, non-English language once she approached them with a request to work together. As a Black math student, these experiences fostered feelings of isolation, and they reduced Makayla to partnering with her professor on group activities.

The representation of intersectionality during her mentorship at the inception of her academic journey at Georgia Tech, combined with her early childhood exposure to math, nurtured Makayla's drive and determination to reach the pinnacle of undergraduate math. In spite of the obstacles she encountered in the classroom, she persevered and cited her positive campus experiences during her commencement speech at Georgia Tech's graduation ceremony in December 2020. As of her graduation, Makayla is one of only 11 Black women to earn a B.S. in Mathematics from Georgia Tech. In Fall 2020, Black students were the most underrepresented group majoring in Mathematics at Georgia Tech with 4.7 percent enrollment compared to 43 percent White, 41 percent Asian, and 4.9 percent Latinx (Student Enrollment, n.d.).

Data Source 1B: Black Georgia Tech Students

These six Black men and women are progressing toward their first degree at Georgia Institute of Technology. The subheadings in this section ascribe each participant's major and anticipated graduation year. The names of some participants have been assigned pseudonyms to protect their identity. Others have consented to using their true names for this study.

Camille Quick, B.S. Environmental Engineering, 2021

Camille is a fourth year undergraduate student at Georgia Tech. She is majoring in Environmental Engineering and is working to graduate with her Bachelor's of Science in the Fall of 2021. She is also a 2017 graduate of Westlake High School. For Camille's mom, it was important to raise her children in the South Fulton community where they see people like

themselves. So routine checkups with their Black pediatricians and doctors, and observing other accomplished Black professionals in medical and STEM fields, directly inspired Camille to pursue a similar track.

As a dedicated tennis athlete, Camille's years in high school were consumed with advanced coursework in her school's Magnet program and intense tennis training and matches. In fact, the perfect marriage of the two is the leading contributing factor for her enrollment at Georgia Tech. Beginning in middle school, Camille's parents signed her up for tennis camps during summers on the elite STEM institution's campus; and after four years, she fell in love with Georgia Tech. While at Westlake, Camille elected to enroll in the Engineering and Technology Pathway where she completed three courses in engineering fundamentals, concepts, and applications. She fervently engaged in rigorous hands-on projects while learning about the foundations, ethics, and processes involved in engineering.

Initially, when planning for college, Camille was torn between attending a predominantly White institution like Georgia Tech or a Historically Black College or University, as she had grown accustomed to the Black experience as a student of Westlake High School in south Fulton County. Fortunately for Georgia Tech, Camille prudently rationalized her decision to attend the esteemed university based on her experiences as a participant in a largely non-Black sport at United States Tennis Association (USTA) events while in high school. Furthermore, as an aspiring environmentalist since high school, Camille understood early that she would work in a White, male-dominated industry post college. In the aggregate, these thoughts and ambitions shaped her decision to attend Georgia Tech.

Jamel Thompson, B.S. Industrial and Systems Engineering, 2021

Jamel is a fourth year undergraduate student at Georgia Tech. He is majoring in Industrial

and Systems Engineering and expects to graduate with his Bachelor's of Science in the Fall of 2021. He, too, is a 2017 graduate of Westlake High School.

Jamel attended Georgia Virtual School in grades third and fourth, which was a highly successful endeavor as he could work at his own pace and would often complete lessons and assignments ahead of schedule. During this homeschooling experience, his maternal grandfather taught him math and science, two subjects he was highly qualified to teach considering he earned his Bachelor's degree in Biology from South Carolina State University. Prior to receiving these formal lessons from his grandpa—a veteran from Aiken, South Carolina who aspired to be a dentist while picking cotton as a young man—Jamel was introduced to STEM concepts and modeling as he was repetitively quizzed by grandpa as early as age three. He took Jamel under his wings; and together, they dissected frogs and analyzed the science and technology incorporated in episodes of Star Trek. Grandpa is largely responsible for cultivating Jamel's STEM curiosities.

Upon reaching middle school, Jamel resumed in-person instruction where his seventh grade math teacher—the only Caucasian teacher at his school—took notice of his advanced intellect. She immediately advocated for his transfer to the eighth grade mathematics class, and this solidified his advanced track. Similarly, the Magnet program at Westlake High School served as an advocate for Jamel given his high academic achievement in science and math. As a predominately Black school, Westlake ardently infused culturally sustaining pedagogy throughout their curriculum and instruction with lesson plans that consisted of in-depth analysis of Dr. Martin Luther King Jr.'s *Letter from Birmingham Jail*, for example.

As a youth, Jamel was a fan of the Georgia Tech football team, and this played a role in his early desires to attend the preeminent school while his academic exceptionalism simply

provided the gateway. However, upon his arrival to Georgia Tech as a first year student, and during his time after, he's encountered intense macroaggressions from his contemporaries of differing ethnic backgrounds. These Georgia Tech peers have gone to extreme lengths to exclude Jamel by asking underlying discriminatory questions such as, "How did you get here?" or making racially charged statements such as, "Oh, you took the ACT and not the SAT," with subliminal references to the ACT being considered the 'Black Test.' Nonetheless, Jamel credits OMED for enriching his Black experience at Georgia Tech—a predominantly White institution in Atlanta, Georgia, a major economic hub in the South. His OMED experiences gained in networking, rigorous course loads, comprehension of the campus layout, communications with university faculty, and meeting prospective employers have proved invaluable. In fact, OMED Challenge largely helped him land a Cooperative Education opportunity with an eminent corporation that can potentially offer Jamel employment after graduation.

Westlake High School to Georgia Tech

Camille and Jamel both completed the Magnet program at Westlake High School. Although Makayla was ineligible to participate in the program as a sophomore transfer, she did request to enroll in several AP courses to include Calculus BC and Physics. As an individual historically partial to math, she chose Physics over Chemistry as she relates the former to applied math.

Camille boastfully eulogizes the intense culture and high academic expectations for the Magnet program students within hers and Jamel's particular graduating class at Westlake. At least eight students were accepted into Ivy League schools, including Camille, who was accepted into Cornell University. They all enjoyed learning as well-rounded, likeable people. They were positively labeled, "The Magnet Students," as they walked the halls of Westlake. Along with this

stereotype and reputation came ancillary benefits such as eating lunch with their AP teachers and early release from class to pursue responsible endeavors. As a proud graduate of the Magnet program, Jamel positively reflects on his enlightening interactions with Ms. Wingfield—a Georgia Tech alumna from Atlanta and former Coordinator of Westlake's STEAM Magnet Program. She offered insight on life as a Black student on the campus of Georgia Tech.

Makayla's proclivities for standardized testing continued through seventh and eighth grade where she completed multiple practice PSAT (Preliminary Scholastic Aptitude Test) exams. Today, she recognizes that she excelled at testing because she was taught to test in a simulated environment. When it came time to officially take the PSAT as a freshman at Westlake, she was devoid of any anxieties and her score was flagged for being extraordinarily high. Consequently, she was given the option to receive free SAT tutoring before school each morning, which inevitably provided her with more resources to achieve a high SAT score. Her comparatively high SAT score ultimately curried favor with the college admissions committee for first year students at Georgia Tech

Similar to Makayla, Camille had an early introduction to the PSAT. As an employee of the Atlanta City Council, her dad was tasked with creating *College Prep Series*—a program designed to help Atlanta's middle and high school students gain admission into the college of their choice (News List, 2017). This prompted him to provide Camille with advanced opportunities and practice tests on an annual basis to provide her with the academic nourishment and preparation for college that he lacked. So when others were just familiarizing themselves with the PSAT at Westlake, Camille knew what to expect and even pragmatically concluded that the ACT was best for her considering it is less conceptual and abstract relative to the SAT.

In summary, Makayla, Camille, and Jamel all benefited tremendously from advanced

coursework—specifically in science—before or during their time at Westlake High School, a predominantly Black secondary institution. Through various college readiness or related programming, they have been prepared for and successful at overcoming racial obstacles purported at Georgia Tech, an exclusive predominantly White postsecondary institution. They each have persevered, not allowing these challenges to infringe on their abilities to pursue high academic achievement in STEM from one of the nation's best STEM-oriented universities—renowned for its #1 ranked Industrial Engineering program in the U.S. in 2020 by U.S. News and World Report (Georgia Institute of Technology, 2021).

Nicole, B.S. Biomedical Engineering, 2022

Nicole [pseudonym] is putting the finishing touches on her Bachelor's of Science in Biomedical Engineering. She is a 2012 graduate of Douglas County High School. Furthermore, she has always favored science because of the creative discovery the field entails.

Nicole's middle school science teacher leaned in on her desires to discover by purchasing Biology books and home science experiment kits for Nicole and allowing her to dissect animals. Then her high school math and homeroom teacher, Mrs. Laura Rader—a two-time graduate of Georgia Tech with degrees in Civil Engineering and Structural Engineering—personally shaped Nicole's perspectives on attending Georgia Tech and convincing her to apply when Nicole initially did not plan to do so. Mrs. Rader wrote Nicole's letter of recommendation for her undergraduate application to affirm her desire for Nicole to succeed at the select university; and she also took Nicole and others on a campus tour of her alma mater.

Douglas County High School (DCHS) is a predominantly Black secondary institution; yet, Nicole was an ethnic minority in her International Baccalaureate (IB) program within the school. This program was the primary attraction for the few White students that attended DCHS.

During her entire elementary and secondary schooling, she did not experience any direct forms of cultural education practices. Moreover, throughout her entire schooling journey, even through college, she has only had four Black teachers total. Therefore, upon reaching Georgia Tech, she immediately found comfort and familiarity with the group colloquially self-branded as "BGT" or "Black Georgia Tech"—a campus community of Black students representing the entire African diaspora. She experienced comfort with BGT while still building and cultivating her friendships with her non-Black peers beginning with her first three roommates in campus housing.

Nicole was raised in a lower-middle class household. This has functioned as a key component of her motivation to attend Georgia Tech, to be successful, and to create upward social mobility for her family. In addition to being upwardly mobile, she remains driven to exemplify hard work and academic achievement for Black or Brown children, or those with disabilities, whose families are of lower socioeconomic status.

Yes, she is grateful for her IB diploma and experiences at DCHS, and the corresponding preparedness it provided for the demanding course load at Georgia Tech. However, retrospectively, she would have preferred to be a dually-enrolled student during her time in high school due to the greater transferability of dual enrollment credits compared to IB credits. Notwithstanding the name recognition Georgia Tech provides by being listed on Nicole's undergraduate diploma as an elite institution—accepted as the second ranked Biomedical Engineering program in the U.S. in 2020 by U.S. News and World Report (Georgia Institute of Technology, 2021)—she would have preferred to attend an out-of-state STEM university and subsequently enrolled in Georgia Tech for graduate school. She lists several reasons for the incitement of this emotion with the most notable surrounding Georgia Tech's classification as an R1 Doctoral University with very high research activity. In Nicole's opinion, this rating has

resulted in the marginalization of several students by faculty who prioritize research over teaching.

Jalen McDowell, B.S. Mechanical Engineering, 2022

Jalen is a third year undergraduate student at Georgia Tech. He is majoring in Mechanical Engineering and expects to graduate with his Bachelor's of Science in 2022. Jalen's paternal grandfather—a Spartanburg, South Carolina native—earned a degree in Industrial Engineering from Orangeburg-Calhoun Technical College in South Carolina in the 1970s when African Americans becoming engineers was less common in the Deep South. He would go on to work for International Business Machines Corporation (IBM); and years later, he served as a major inspiration and influence on Jalen's STEM trajectory.

In terms of Jalen's experience with cultural education practices, he had one social studies teacher at Henry County High School that implemented culturally relevant pedagogy, specifically during Black History Month. She also encouraged Jalen and his peers to be politically conscious and active participants in the community by voting and exercising their democratic rights as Black citizens. This engagement between Jalen and his teacher had no direct or indirect impact on his STEM journey throughout high school. Jalen does, however, speak to being pushed harder by Black administrators and teachers relative to those of other races; and he was earnest in performing at his best because of their urging for him to do well. That said, Jalen performed exceptionally well in AP Calculus and AP Physics.

Jalen took classes in engineering and 3-D modeling and gained valuable familiarity with project-based learning in these courses. "It was more fun!" said Jalen. "You can learn the same by doing hands-on projects and collaborating with other people instead of textbook memorization and worksheets." Jalen cites these experiences for boosting his interest in STEM

and for his decision to pursue a college degree in these fields.

Alaika Suffrena, B.S. Chemical and Biomolecular Engineering, 2022

Alaika is a third year undergraduate student of Haitian descent at Georgia Tech who was born in Haiti, but moved to the U.S. at age seven. She is majoring in Chemical and Biomolecular Engineering (ChBE) and plans to graduate with her Bachelor's of Science in 2022. A self-proclaimed numbers person, Alaika completed her Associate's degree while earning her high school diploma as a dually-enrolled student at Henry County High School. Through hard work, good fortune, and faith, Alaika received a G. Wayne Clough Georgia Tech Promise Program scholarship, among others, prior to the beginning of her first fall semester. Her mother had her at a relatively young age, and her father was a Haitian refugee. These two facts underscore Alaika's meteoric rise in STEM, considering the insurmountable odds she has faced since birth.

Alaika completed elementary and middle school in Brooklyn, New York. Because she was greatly challenged through the eighth grade, high school in Georgia oftentimes felt easier with exception to her dual enrollment coursework. In New York, a passing score on the state's end of grade examinations was required to be promoted; and these tests resembled the SAT for Alaika. Therefore, she was beyond prepared to sit for the SAT later once she reached high school in the South. She achieved an outstanding score because of her advanced preparation on an annual basis while up North.

As a first year undergraduate at Georgia Tech, Alaika embraced her experience with the Office of Minority Educational Development (OMED) under the mentorship of a third year Chemical Engineering major. This bright intellectual of color provided extraordinary insight into the Black experience at Georgia Tech, which enabled Alaika to withstand instances of subliminal or unintentional discrimination characterized as "microaggressions." Mentorship is one of the

major enablers of Alaika's personal success. Due to this, she has always pursued the guidance of people who look like her, specifically successful Black women.

Alaika is keenly fond of teachers and professors who believe in her and are passionate about what they teach because their energy is contagious. Throughout her elementary and secondary educational journey, and even while dually enrolled, she constantly came across eager educators of this caliber. Conversely, during her time at Georgia Tech she has encountered instructors who do *not* believe in her with troublesome regularity. This postsecondary teacher-apprentice dynamic has only conjured her motivation and stoked the flames of her resilient work ethic.

Victoria, B.S. Industrial Design, 2022

Victoria [pseudonym] is a third year undergraduate student of Jamaican descent at Georgia Tech who was born in Canada. She is majoring in Industrial Design and is working to graduate with her Bachelor's of Science in 2022. In Fall 2020, Black students were the most underrepresented group majoring in Industrial Design at Georgia Tech with four percent enrollment compared to 48 percent White, 33 percent Asian, and eight percent Latinx (Student Enrollment, n.d.). Moreover, Victoria has an older female cousin who was a key influence on her decision to pursue and academic pathway in STEM. While in middle school, her cousin was attending classes at Georgia Tech as a Mechanical Engineering major who went on to earn her Bachelor's of Science soon thereafter. One day, her cousin invited her on campus to a luncheon specific to Black women in STEM. This is the genesis of Victoria's desire to align herself with other creative minds—particularly those who look like her that she identifies with culturally—with the objective of positively affecting society.

Fast forwarding to her time at Henry County High School, Victoria participated in

Summer Engineering Institute (SEI)—a three-week residential program for minorities interested in STEM on the campus of Georgia Tech. She won first place in the engineering design competition, which heightened her confidence and focus. The world of STEM became her oyster! Though abundantly grateful for her opportunities, she empathetically remained connected to the portion of her high school student body that lacked resources and institutional knowledge that could have propelled their academic progress.

Without the benefit of college tours in high school, pieces of Victoria's involvements with Georgia Tech leading up to this moment were framed together to form a gorgeous mosaic of foreshadowed experiences she would encounter at an elite institution in the heart of Atlanta—ranked #11 for Undergraduate Research/Creative Projects in the U.S. in 2020 by U.S. News and World Report (Georgia Institute of Technology, 2021). Contrarily, her expectations have continually been misaligned with her reality since she reached campus in Fall 2018, resulting in varying levels of disappointments. She experienced explicit prejudices for being among the most intersectional as a triple minority: Black, woman, and gay. There were extreme moments where she feared for her life while on campus largely due her intersectionality.

Victoria retrospectively internalizes her emotions surrounding the communal abandonment she sensed as she observed Asian groups band together to prepare for tests while no one in her labs would extend a helping hand because she looked different. In virtual group chats, she realized that her peers are more apt to respond to her questions once she changed her profile picture to her all-white Yorkshire Terrier. These events produced feelings of inadequacy among the impeccably intelligent; and she firmly feels that the weight of her experience could cast a dark shadow over the respected university that paradoxically provides her with a full academic scholarship. Nonetheless, she remains resilient with a lionhearted outlook as she treks

along course by course toward the finish line where her degree awaits her.

Henry County High School to Georgia Tech in 2018

In Spring 2017, Georgia Tech unveiled their Scholars Program. This initiative automatically accepts valedictorians and salutatorians from any accredited Georgia high school with 50 or more graduates, provided a minimum SAT or ACT score, and math credit at the pre-calculus level or above (Georgia Tech Scholars Program, n.d.). Just one year removed from the implementation of this policy, Jalen and Alaika were named valedictorian and salutatorian, respectively, in their 2018 graduating class at Henry County High School (HCHS) of Henry County School District, where Victoria finished third in their class.

For context, Henry County High School, now McDonough High School, is located in a southeast suburb of Atlanta, Georgia; and it presently serves a student population of greater than 80 percent African American students with more than 60 percent of the overall study body receiving free or reduced price lunch. All three HCHS alumni speak fondly of Black Engineering teacher, Mr. Hugh Broderick, who recognized their STEM talents as high school freshman and sophomores. Mr. Broderick decided early on to cultivate their interests to maximize their opportunities as STEM specialists; and he pushed their math and science limits in a multitude of ways. According to Alaika, he mandated that each student in his class apply for dual enrollment at Southern Crescent Technical College at their Henry Academy for Advanced Studies. Furthermore, his teaching went beyond projects, homework, and grades. He imbued life lessons that prepared his students—most notably African Americans—for their handlings of microaggressions.

According to Jalen, Mr. Broderick taught with unfettered joy and inspired his students to persistently seek enlightenment. Victoria recalls an engineering project in Mr. Broderick's ninth

grade class that required each student to competitively design a doorstop with the winner's finished product being manufactured in class by all students for consumers to purchase. This was an eye-opening endeavor for Victoria—winner of the design competition—as it affirmed her ideas for consumers' willingness to buy products that are a result of dedicated and talented craftsmanship. She also reflects on the controversial first draft of her graduation speech that received disapproval from the school's Principal. The speech consisted of references to McDonough, Georgia, historically being a hotbed of racial tension with a confederate statue remaining upright in the town square since 1910. Mr. Broderick encouraged Victoria to remain "loud and proud" during this contentious time. Because she hadn't yet received a scholarship from Georgia Tech, Victoria reluctantly modified her speech in an effort to avoid jeopardizing her academic future. The monument was ultimately taken down in July 2020—two years after graduation.

Both Alaika and Victoria participated in the Georgia Governor's Honors Program (GHP), a selective initiative that provided gifted high school juniors and seniors with opportunities for science modeling and inquiry-oriented project-based learning. Moreover, they each enthusiastically extol their mothers' contributions to their academic successes as immigrants of Haiti and Jamaica, correspondingly. In terms of influential parents, Jalen also references his mother's interminable support to learn, grow, and excel academically.

Findings

In order to achieve academic excellence in STEM as Black students, the researcher believes that advocacy from teachers or administrators is required with few exceptions. Additionally, the researcher believes that cultural education practices are effective for underrepresented minority students and *doing* science is effective for *all* students. Next, the

researcher believes that the organization of schools drives student achievement. Moreover, it is the researcher's position that standardized tests are uninspiring for students gifted in STEM. Finally, the researcher argues that STEM interests for African American students must be elevated with college readiness or related programming.

In total, eight Black men and eight Black women participated in this study. These STEM talented individuals attended high schools across the following Metro Atlanta school districts: Atlanta Public Schools, Cobb County School District, DeKalb County School District, Douglas County School System, Fulton County Schools, Gwinnett County Public Schools, and Henry County School District. Of the 16 participants in this study, ten finished high school in the last ten years; and twelve attended predominantly Black high schools. Nicole, a 2012 graduate of Douglas County High School, explains the racial composition of her school by the following, "In classrooms, I was the minority. In the IB program, there were 65 students and only ten of us were Black. However, my school was 80-plus percent Black; and most of the White kids that came to my school were only there because of the IB program." Her recollection is an unfortunate reference to the historical lack of Black representation in STEM even in schools overrepresented by Black students. The next section thematically captures the STEM journeys to Georgia Tech of these participants (see Table 6).

Table 6. Journey to Georgia Tech

	Alaika Suffrena	Andre Dickens	Austin Card	Camille Quick	Isaac Campbell	Jalen McDowell	Jamel Thompson	Janelle Wingfield	Makayla	Norman Harris II	Nyima Piaro	Nicole	Victoria	Bryan Richards	Sybrina Atwaters	Tiffany
High school: graduated in last 10 years	X		X	X		X	X		X	X	X	X	X			
Advanced science courses		X	X	X	X		X	X	X	X	X	X			X	X
Advanced engineering courses	X					X					X		X			
Advanced mathematics courses		X	X		X		X	X	X	X		X		X		X
College readiness/related programs		X		X			X		X	X		X	X		X	X
Cultural education practices, experience with	X	X		X	X	X	X		X	X			X	X	X	X
Predominantly Black high school	X	X		X	X	X	X	X	X			X	X	X	X	
Parents as immigrants	X								X		X		X			
Parents or grandparents employed by IBM			X			X				X						
Inquiry-oriented and project-based learning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Academic competition participant	X	X				X	X				X		X		X	X
Advanced STEM track before or during high school	X	X	X	X	X	X	X	X	X	X	X		X			X
STEM advocate affected success	X	X	X	X	X	X	X	X	X		X	X	X	X		

Journey to Georgia Tech

Theme 1: STEM Advocacy

Eighty-one percent of participants were placed on an advanced STEM track before or during high school. Councilman Dickens recalls being tested at the inception of middle school and then placed on an advanced math track. Moreover, advocacy played a major role in the STEM elevation of the participants with 13 of 16 naming specific school leaders who contributed to their success, advocating for advanced coursework. Here is an example of implementation of the third concept of the anti-deficit achievement framework—known as *attribution theory*—whereby traditionally marginalized groups recognize attributors to their success. Jamel appreciatively reflects on his seventh grade math teacher recognizing his proficiency and advocating for his transfer to eight grade math. His teacher continued her advocacy by becoming certified in ninth grade math so she could instruct Jamel once he reached the eighth grade.

Gifted Education. Of the 16 participants, half spoke of being branded as *gifted* and participating in their school district's pull-out program. Furthermore, eight of the participants partook in an academic competition for the academically elite. For Nyima, it was during this time that he forged a bond with his middle school science teacher who inspired him to go beyond the standard science curriculum.

Theme 2: Pedagogy

Cultural Education Practices. Only twelve participants were taught by teachers implementing culturally relevant, responsive, or sustaining pedagogy. Initially, the expectation was that this number would be higher; however, four individuals went on to achieve greatly in STEM despite their absence of exposure to these pedagogies. This is evidence of correlation between STEM success and cultural education practices but not causation. While Austin did not directly receive these types of instruction at Pope High School, having an Honors Chemistry

teacher that he could culturally identify with brought him comfort in the classroom and inspired him to put his best foot forward.

Makayla articulated her appreciation for the cultural rapport she had with teachers at Westlake High School. "[Because] my teachers were Black, I could communicate with them a little bit more," she iterated. Although Dr. Bryan Richards has not been able to link culturally relevant pedagogy to his STEM journey, he proudly proclaims, "My schools were predominantly Black, [and] we sang 'Lift Every Voice and Sing'," referencing James Weldon Johnson's poem, later popularized as the *Black National Anthem* by the NAACP in 1919 (Chow, 2020). "There was a sense of pride in who we are," he continues. It is important to distinguish having Black teachers and experiencing education with a backdrop of Black culture from the traditional definitions of culturally relevant, responsive, and sustaining pedagogies. However, Dr. Richards and Makayla are proof that cultural education practices come in many forms.

Doing Science. All contributors to this study participated in inquiry-oriented and project-based learning at some point or another throughout their STEM journey. Being able to apply their knowledge in various environments has been a key component of their achievement. "It's just more fun!" Jalen vibrantly stated. "You can learn the same things while doing hands-on things and collaborating." Research supports hands-on science at a catalyst to student development of science content knowledge (National Academies of Sciences, 2015a, p. 29).

Theme 3: School Organization

Across the board, as each candidate thrived in advanced coursework, the expectations for them to remain successful only increased. "Overall, expectations were pretty high," Norman tells. However, expectations for him specifically were lower academically as an athlete who participated in sports at Kennesaw Mountain High School and eventually Whitefield Academy

despite being accepted into Princeton University purely on the merits of his academics.

Camille reveres how all of the students in the Magnet program at Westlake were struggling but wanted to do well as high achieving students: “There was an underlying feeling that we didn’t want to be in the general classes—we wanted to succeed, and we had high expectations for ourselves.” Furthermore, there were high expectations from their AP teachers, and they had to complete an excessive amount of work; but she believes that it prepared them for college. As a graduate of Benjamin E. Mays High School, Andre adoringly reflects on the school culture and expectations for students to succeed. “Dr. Benjamin Elijah Mays was a super giant in the education world as the advisor and mentor to Dr. Martin Luther King Jr. and President of Morehouse [College] so we all had to be excellent—excellence was all we knew!” he recalls.

Victoria bemoans the general culture at Henry County High School, and that it was created largely because the majority of students lacked an interest in achieving high academic standards. “How does no one see that there’s a whole group out here being malnourished?” she frequently asked herself regarding the members of her community and the students of her school relative to other schools. Inversely, according to Victoria, “a lot of the teachers were open to when you *do* care and when you *are* trying,” considering the majority of her classmates did not match her level of pride in their school work.

Theme 4: Standardized Testing

With few exceptions, nearly all of the participants bewailed the monotonous process of standardized testing that they were subjected to during their K-12 experience. Nyima stated, “I knew that if I didn’t pass those [non-STEM] tests, I wouldn’t be able to move on to STEM.” Similarly, Austin pronounced that learning *how* to take the test was all he needed to complete standardized assessments. Conversely, Jenelle consistently scored in the ninety-eighth or ninety-

ninth percentile on the Iowa Test of Basic Skills (ITBS) examination from sixth through eighth grade, and her scores were announced over the school intercom, much to the dismay of her peers. However, she still abhorred the assessments: "It was a necessary evil, but it came easy to me."

Theme 5: College Readiness or Related Programming

College readiness or related programs were a key enabler of STEM success for 56 percent of participants: Minorities Interested in Technology and Engineering (MITE), Summer Engineering Institute (SEI), and the Challenge program offered by the Office of Minority Educational Development (OMED) at Georgia Tech, to name a few. While Jenelle missed out on college readiness programming, particularly during the summer succeeding high school graduation, she praised the opportunity given to her by enrolling in summer classes. "I met some of the most amazing human beings [that summer] at Georgia Tech," Jenelle enthusiastically quoted with reference to fellow alumnae such as her good friend and activist, Nsé Ufot.

Experiences at Georgia Tech

All participants in this study either graduated from Georgia Institute of Technology or are currently enrolled at this elite institution, recognized as the fourth most innovative school in the U.S. in 2020 by U.S. News and World Report (Georgia Institute of Technology, 2021). Of the 16 participants, ten received their first degrees awarded by Georgia Tech from the College of Engineering, and three from the College of Computing. Six participants are first-generation college students, seven have either completed or are working toward a graduate degree from Georgia Tech or another institution, and three changed their major at least once while attending Georgia Tech. "I started off as [a] Nuclear Engineering [major]. I thought it sounded cool," Jamel jovially revealed. Table 7 highlights consistent involvements experienced by the participants while attending Georgia Tech as undergraduate or graduate students.

Table 7. Experiences at Georgia Tech

	Alaika Suffrena	Andre Dickens	Austin Card	Camille Quick	Isaac Campbell	Jalen McDowell	Jamel Thompson	Janelle Wingfield	Makayla	Norman Harris II	Nyima Piaro	Nicole	Victoria	Bryan Richards	Sybrina Atwaters	Tiffany
First-generation college student	X	X					X	X		X				X		
Georgia Tech College of Engineering degree program	X	X	X	X		X	X		X		X		X	X		
Georgia Tech College of Computing degree program				X						X					X	
Other STEM degree program from Georgia Tech							X	X				X				
Bachelor's degree outside of Georgia Tech			X										X			
Completion or working toward graduate degree		X	X		X		X		X					X	X	
Active participant in the Office of Minority Educational Development (OMED)	X					X		X	X					X		
Changed major at least once						X		X				X				
Non-CS major with affection for coding	X		X						X							
Experienced bias	X							X	X		X	X				

Theme 6: Being Black at Georgia Tech

Several participants described how being Black at Georgia Tech has come with its unique set of challenges. “Like everybody else, I overcame whatever obstacles I had to overcome, and I never felt as if people were in my way,” Dr. Isaac Campbell pronounced. Conversely, Alaika condemns what she considered blatant racialization from her classmates in the presence of her professor in an elective course. In this occurrence, a group of her non-Black peers constructed a project representing the culture of companies that consisted of machinery being portrayed as Black people who spoke with profane-laced colloquialisms. The idioms and dialects used were associated with people of color from lower socioeconomic backgrounds with limited resources. “As a Black woman, I felt disrespected by that presentation,” she voiced to her professor after class. His only retort was a question asking her, “What do you want me to do?” Precisely five participants in this study expressed that they’ve experienced bias on campus in some form or another. These are examples of the application of the fourth concept of the anti-deficit achievement framework—known as *campus ecology theories*—whereby Black men and women accentuate their abilities to flourish in predominantly male or White STEM environments. Moreover, Alaika’s response was an example of *stereotype threat theory*, the second concept, where she respectfully responded to negative stereotypes in the classroom.

OMED. The Office of Minority Educational Development (OMED) has proven pivotal to enhancing the Black experience at Georgia Tech for several of the participants in this study. Various programs in OMED allowed them to connect with other minority high achievers at the institute. OMED Challenge is a five-week summer program encompassing rigorous college preparation for incoming first-year minority students at Georgia Tech. For fully engaged participants, Challenge has proven to considerably boost academic attainment in the first fall

semester for these students. In addition to the demanding course load, the enrichment component gives prospective students a taste of college life as independent young adults while holding them accountable as aspiring scholars. “I got to see that I wasn’t really prepared as I thought I was for [Georgia] Tech,” said Jamel.

“That was my first time in a program surrounded by people who looked like me [and] that was incredibly beneficial,” Norman emphatically proclaimed. “Going into college and having a summer where you’re taught by people who look like you [was] huge for me!” he continued with reference to the Black counselors, program leaders, and instructors in Challenge. Being taught by these leaders to sit in the front of classrooms and introduce one’s self on the first day of class had immeasurable value to the Black STEM scholars at Georgia Tech from Atlanta, and others, who were fortunate enough to partake in OMED Challenge.

Alaika commends the career-based workshops and related programming provided by OMED such as Women of Color Initiative (WOCI). “OMED is definitely well-rounded, socially and educationally,” she added. WOCI provides advocacy and support for Black and Brown women of Georgia Tech, empowering them with opportunities to advance their studies and eventual careers.

OMED and its various programs have loomed large in the holistic experience of Black students at Georgia Tech, specifically the participants in this study. Overall, it has increased enrollment, retention, and graduation of Black men and women. “Challenge put me in touch with the community that helped me get to the point of graduating,” Norman quoted with great appreciation. OMED is currently thriving under the leadership of Director, Dr. Sybrina Atwaters—a contributor to this study.

Theme 7: School Organization at Georgia Tech

Several participants of this study censure the intense academic culture and expectations to perform at a supreme level during their time as students of Georgia Tech, while simultaneously grasping the purpose of upholding the university's high standards. "The culture at Georgia Tech will make you question what you signed up for and what you're there for," Tiffany asserted. Dr. Atwaters emphasized, "At some point, I was surviving." She fondly recalls being told that she could achieve greater by her mentor and the former Dean of the College of Engineering, Dr. Gary May, after he informed Dr. Atwaters that she had received a 'B+' on her electrical engineering exam.

School culture and school and teacher expectations at Georgia Tech have operated as drivers for these leading STEM performers to persevere and achieve. They have set themselves apart from their peers. Most of the participants in this study believe that their rigorous work load prior to enrolling at Georgia Tech, combined with any college readiness programming they had access to, prepared them for the arduous academic journey and how to deal with peripheral challenges that come with being Black at a predominantly White institution.

Data Source 2: A Quantitative Descriptive Analysis

In this quantitative descriptive analysis, the following core question was answered: What are the average pass rates in advanced level STEM courses over a five-year period at the district level? Additionally, another core question under examination was the following: What is the Black-White achievement gap between distinguished performing students at district and school levels in basic STEM course takings? Furthermore, an analysis of school district enrollment and the postsecondary enrollment of students from these districts can provide context to the educational journeys of the participants in this study from Georgia Tech.

Advanced Placement Testing

This quantitative exploration of STEM representation and achievement at the Metro Atlanta school districts where the Georgia Tech study participants attended high school begins with an analysis of Advanced Placement (AP) test scores. The researcher prefers to begin here because all majors at Georgia Institute of Technology require coursework equivalent to Calculus I (Course Requirements by Major, 2019). A student must receive a score of three or higher to pass an AP exam and receive college credit for the course. AP data is not disaggregated by race or gender. However, it's important to note that literature states that females typically earn higher grade point averages in high school upon entering college, but are less likely to have taken calculus, chemistry, and physics (Weeden et al. 2020, p. 7).

From 2015 to 2019, Fulton County Schools (FCS) experienced the highest pass rate for both AP Calculus A and Calculus BC of the seven school districts evaluated in this study. FCS achieved this feat while boasting the highest number of tests taken in these subjects per 1,000 students (see Figure 2). FCS also had the highest pass rate for AP Computer Science A, Physics 1, Physics 2, and Chemistry—more than half of the subjects analyzed (see appendix D). Although DCSS experienced the lowest pass rate of the eight subjects analyzed across the seven districts overall, this district had the most number of tests taken per 1,000 students in both AP Computer Science courses and AP Chemistry. Most charter schools are not included in the data.

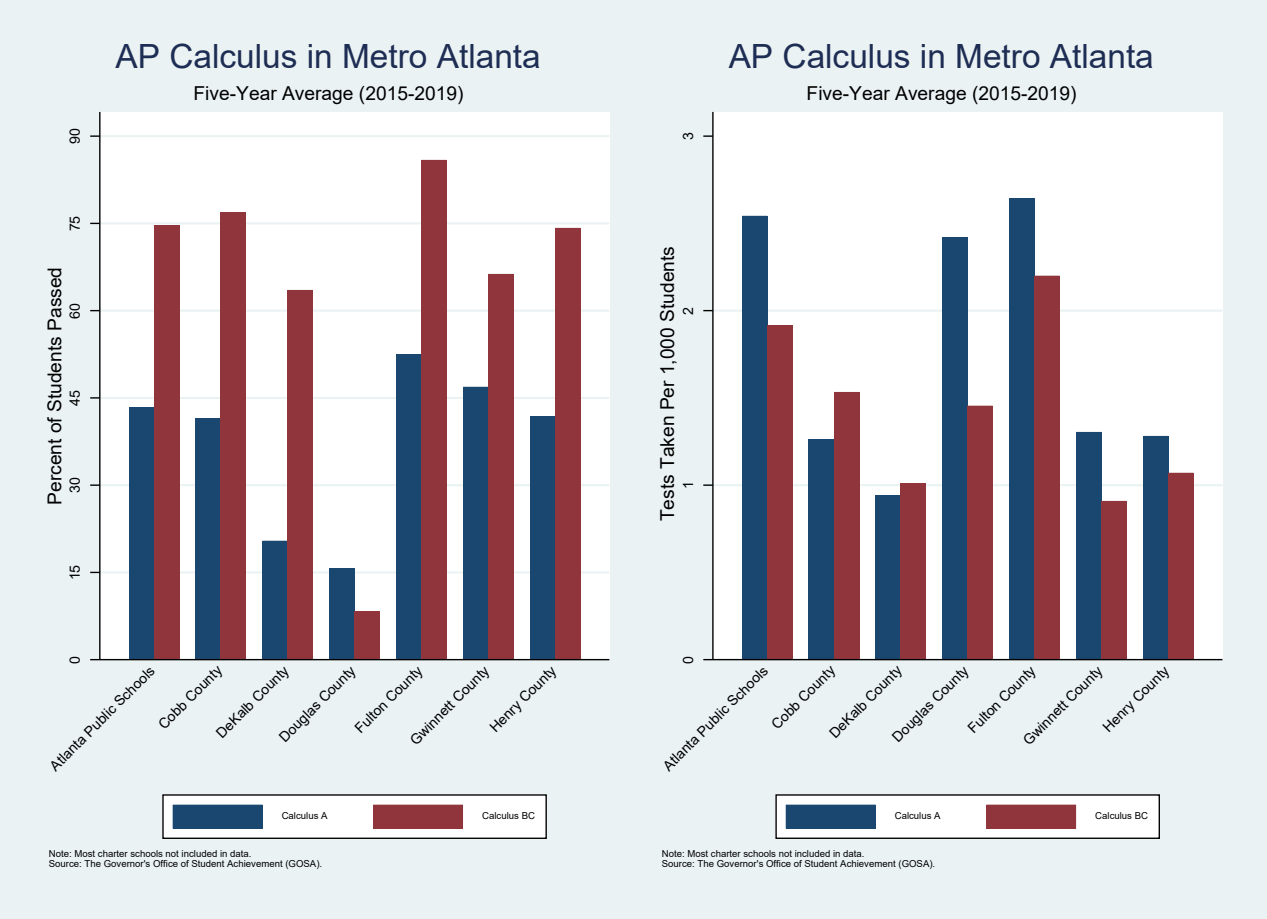

Figure 2. AP Calculus in Metro Atlanta (2015-2019)

Postsecondary Enrollment

Understanding the demographic trends of postsecondary enrollment of Metro Atlanta students can add context to the paucity of Black students enrolled at Georgia Tech. Of the high schools in the seven Metro Atlanta school districts evaluated over the three-year span between 2015 and 2017, only DCSS and HCSD experienced a higher percentage of Black graduates enrolled at a postsecondary institution relative to White graduates (see Figure 3). Coincidentally, until 2019, these were the only two of the seven districts that witnessed a continual rise in their enrollment percentage of Black students beginning in 2015. Between 2015 and 2017, high schools in each district experienced a greater percentage of female graduates who enrolled at a

postsecondary institution than male graduates. Appendix E displays the postsecondary enrollment trends within each school district by subgroup. Over this stretch, for each subgroup, GCPS saw a steady decline in postsecondary enrollment. Most charter schools are not included in the data.

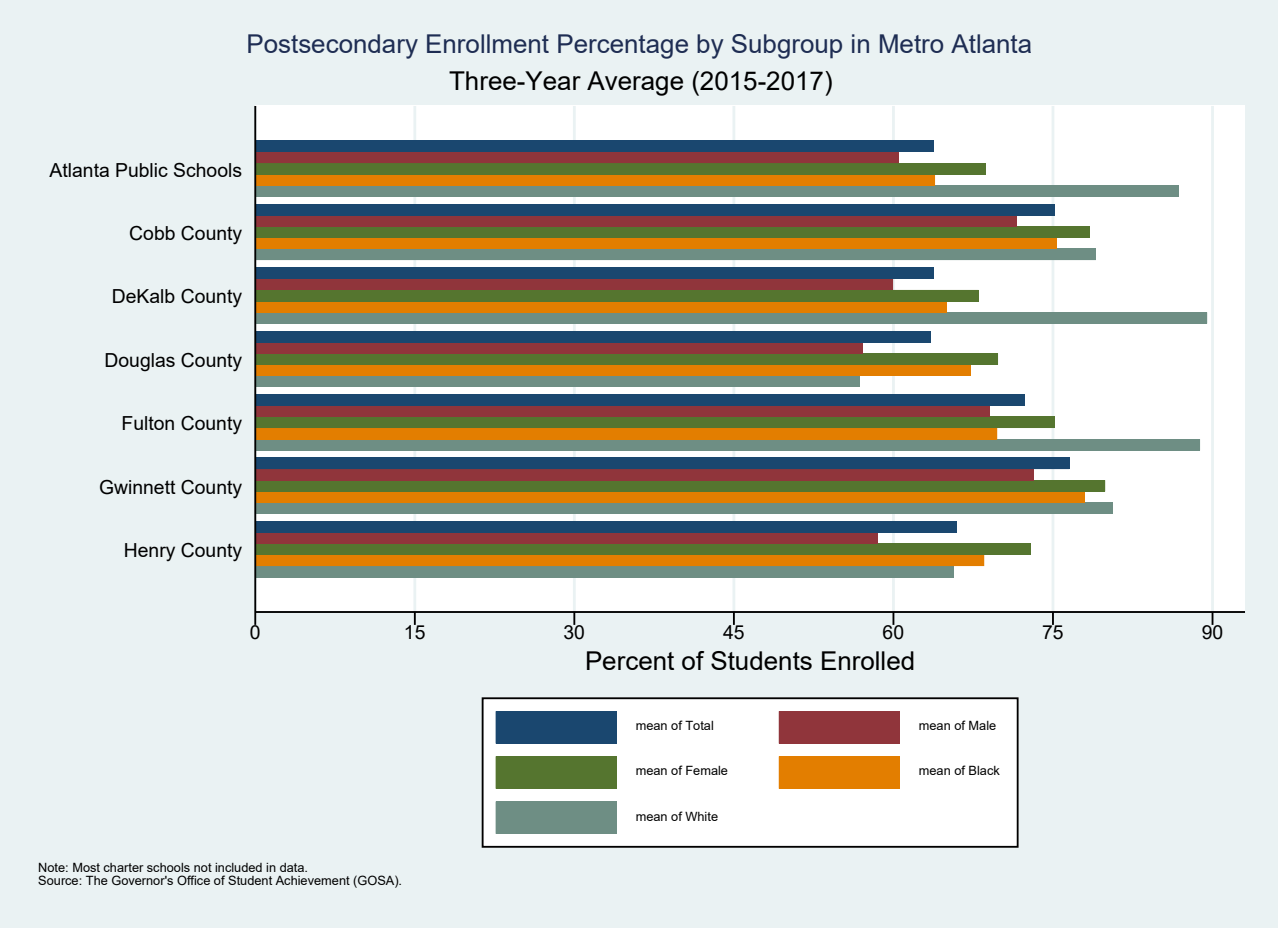

Figure 3. Postsecondary Enrollment Demographics in Metro Atlanta School Districts

End-of-Course Scores: Achievement Gaps

Before enrolling in AP courses, it is incumbent upon students to perform at levels beyond proficient on general state exams. While not required, high achievement on these exams can provide a measurable baseline to forecast one's performance in advanced level coursework. The state standardized test is the Georgia Milestones Assessment System or end-of-course (EOC)

measures for high school students, whereby these students are tested in ten courses (Georgia Milestones Assessment System, 2021). EOC scores for schools in the seven Metro Atlanta school districts were used to assess performance gaps over five years between the highest achieving Black and White students in math and science subjects (see Table 8). Recognized as *distinguished*, these high performing boys and girls are among the elite academically relative to their specific subgroup and the student body at their school as a whole. Over the course of five years, APS had the highest average of total Black students tested by far at 81 percent. The next closest was DeKalb County School District (DCSD) at 71 percent. As anticipated, APS experienced the largest Black-White achievement gap among distinguished performing students in math and science. The next highest was Fulton County Schools.

Appendix F displays the percentage of Black students and White students who completed math or science EOC testing for schools within each district over a five-year timeframe. Furthermore, this appendix shows the percentage of Black students and White students who performed at distinguished levels relative to the total amount of Black students and White students, respectively, who tested in math or science. Lastly, achievement gaps at each school were calculated by taking the difference between the percent of Black distinguished performing students and White distinguished performing students. It is important to underscore that many schools—such as Hillgrove High School and Kennesaw Mountain High School of CCSD and Brookwood High School of GCPS—witnessed distinguished performance in math or science for Black students at a relatively high rate. However, the achievement gap between Black and White students persisted at these schools.

The math and science subjects used for this data include Algebra I, Analytic Geometry, Biology, Coordinate Algebra, Geometry, and Physical Science. Middle schools and most charter

schools are not included in the data. Additionally, only schools where Black students were tested are included. Attempts were made to only include traditional public schools for the purpose of evaluating uniform curricula established by the state board of education.

Table 8. EOC Math & Science Achievement Gaps in Metro Atlanta School Districts (2015-2019)

District	Percent_Tested_Black	Percent_Tested_White	Percent_Distinguished_Black	Percent_Distinguished_White	Achievement_Gap
Atlanta Public Schools	81.0%	8.7%	0.7%	28.9%	-28.1%
Cobb County	33.3%	37.3%	3.1%	27.2%	-24.1%
DeKalb County	71.1%	6.5%	0.9%	25.1%	-24.2%
Douglas County	55.6%	22.8%	2.0%	7.2%	-5.2%
Fulton County	43.6%	29.9%	1.4%	28.3%	-26.9%
Gwinnett County	33.9%	22.0%	5.2%	22.5%	-17.3%
Henry County	55.6%	26.9%	0.8%	5.6%	-4.8%

Note: Middle schools and most charter schools not included in data. Only schools with Black students tested are included.

Source: The Governor's Office of Student Achievement (GOSA).

K-12 Enrollment

Of the high schools in the Metro Atlanta school districts evaluated over the five-year span between 2015 and 2019, all of them except Cobb County School District (CCSD) served more Black students than any other race (see Figure 4). During this time, the high schools in Atlanta Public Schools (APS) experienced enrollment of over 80 percent Black boys and girls. Appendix C displays the enrollment trends within each school district by race. CCSD and Gwinnett County Public Schools (GCPS) have both experienced a steady enrollment percentage increase of Hispanic students while Henry County School District (HCSD) saw a gradual climb in their enrollment percentage of Black students. Most charter schools are not included in the data.

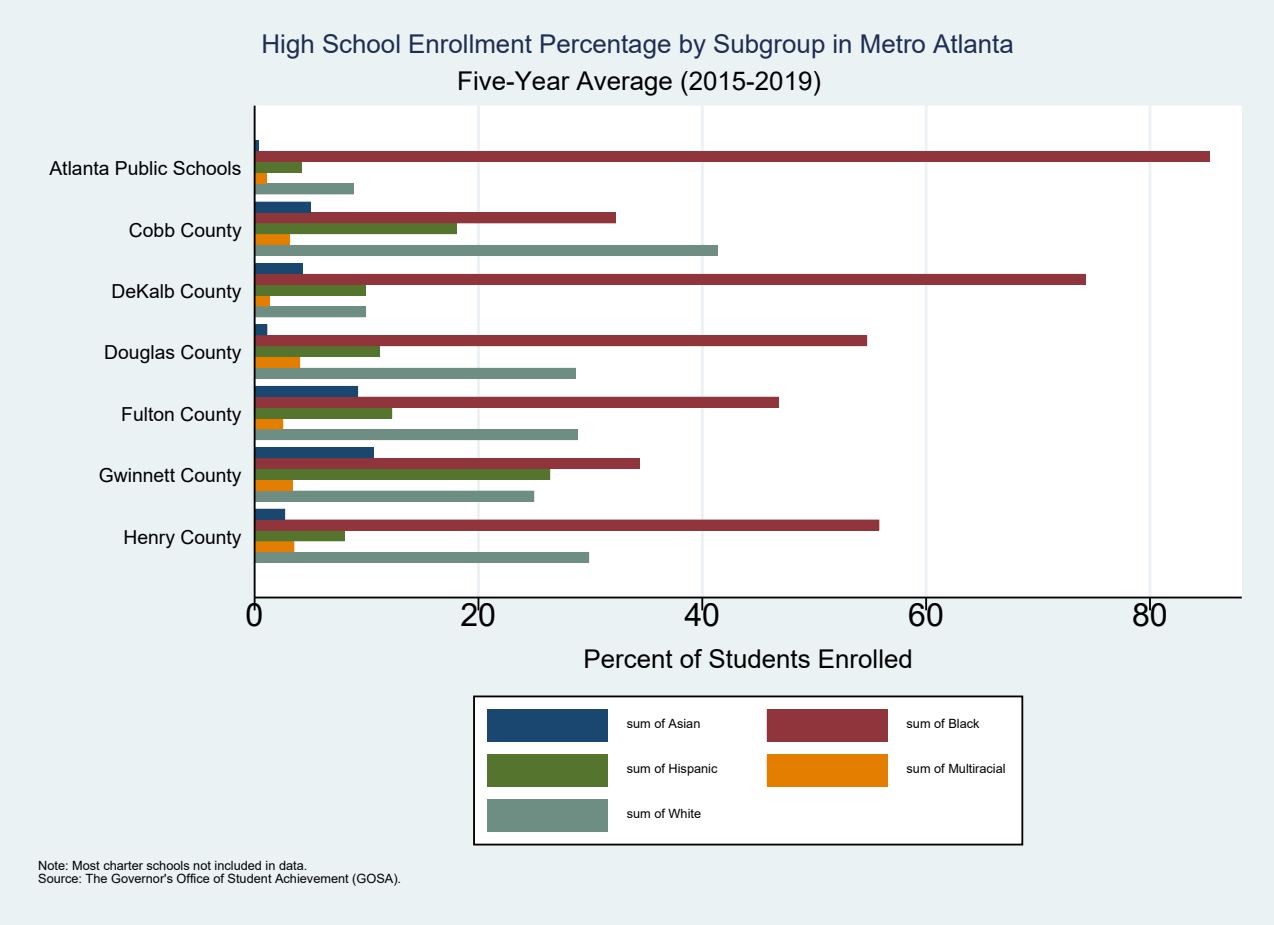

Figure 4. Enrollment Demographics in Metro Atlanta School Districts.

Conclusion

In summary, APS—a school district with more than 80 percent Black student enrollment—was among the lowest performing districts in Computer Science, Biology, and Chemistry, in terms of student pass rate on Advanced Placement tests. Conversely, in AP Calculus and AP Physics 1, APS was proudly among the highest achieving while also having the most amount of tests taken. Paradoxically, APS had the largest Black-White achievement gap between distinguished performing students in basic STEM course takings in addition to having the lowest percentage of Black graduates enrolled at a postsecondary institution.

Although the inverse relationship between school district enrollment of Black students and the percentage of Black graduates attending college is evident, there are obvious inconsistencies in the performance of all students at each school district in advanced level math and sciences courses. District-level K-12 and postsecondary enrollment data confirms and contextualizes Black-White achievement gaps in math and science. However, enrollment data does not support the varying performance levels in advanced math and science courses between each school district. Perhaps if Advanced Placement data was disaggregated by race and gender, STEM outcomes might correlate with enrollment demographic data.

Getting Black students to distinguished performance levels in math and science—therefore, narrowing Black-White achievement gaps—is achievable even in schools serving majority Black students. However, equitable and adequate allocation of resources is needed to accomplish this feat. The next section qualitatively assesses these resources, systems, and structures that enable the elevation of Black students in STEM.

Data Source 3: Mechanisms Enabling School Success in STEM

The primary participants in this study are administrators and teachers of Black students

well-represented or high achieving in STEM at a large urban school system in Metro Atlanta. This school district is home to several schools named after prominent Black leaders in our country's history as well as Atlanta, Georgia history; and these schools each have greater than 90 percent Black student enrollment. The district has piloted a cutting-edge signature K-12 program for STEM and STEAM education.

Through community partnership with Georgia Tech, this school district is able to provide AP Computer Science courses to their students spearheaded by equity in computing initiatives. Furthermore, other programs and workshops at Georgia Tech have proven instrumental to the STEM development of students at this district through various STEAM-focused summer camps that expose students to different STEM/STEAM topics. In this urban school district, brotherhood is emphasized among the Black males, and there is an elevated level of attention on evolving Black females into STEMinists, defined as anyone fighting for representation of women in STEM.

School Leaders

Six of the seven participants of this study—referred to as *Leaders*—work at five different schools across the same urban school district. These five schools effectively operate within the same STEM/STEAM program. The seventh school leader works at a neighboring school district as the director of the STEM-oriented Magnet school within a school in Metro Atlanta.

School Leader 1, School 1. Leader 1 has obtained his or her Doctorate of Education and recently completed his or her fifth year in the role of STEAM Coordinator at School 1. He or she leads 31 STEM teachers who only teach math and science subjects to the students at School 1. Prior to working at School 1, Leader 1 served in the capacity of Department Chair and Content Specialist at other K-12 locations within Metro Atlanta.

School Leader 2, School 2. Leader 2 has worked at School 2 for twelve years in various capacities, beginning as a teacher of science and Science Department Chair. He or she has been the STEM Program Specialist at School 2 for the last three years. Leader 2 has a Master's degree in Science Education and another in Curriculum and Coaching. Initially headed for Pharmacy with a B.S. in Chemistry and Biology, he or she changed course and began working in Teach for America immediately upon graduation.

School Leader 3, School 3. Leader 3 is STEM Coordinator and AP Computer Science teacher at School 3. Additionally, he or she is the Engineering instructor for all levels—Foundations, Concepts, and Applications. Leader 3 is presently in his or her fifth year at School 3 with prior experience working at other schools within this same urban school system.

School Leader 4, School 4. Leader 4 is in his or her fifth year as the Signature STEM Instructional Coach at School 4. The role of Leader 4 was created specifically for the STEM Signature Program. Prior to, he or she worked as an instructional coach for science at School 4 with previous experience coaching teachers within this large urban school system and other neighboring school systems for over a decade.

School Leader 5, School 1. Leader 5 teaches Computer Science, Music Technology, and Mathematics at School 1. He or she is completing year three at School 1 and is an alum of the school, graduating more than 20 years ago. Leader 5 holds a Specialist degree in Mathematics and will soon begin his or her Doctorate.

School Leader 6, School 5. Leader 6 handles all things STEM at School 5 as the STEM Program Specialist. He or she is a teacher of eleven years, but has operated in this particular capacity for four years. Leader 6 has earned his or her Master's degree and is currently enrolled in a doctoral program.

Findings

The primary participants in this study are administrators and teachers of Black students well-represented or high achieving in STEM at a large urban school system in Metro Atlanta. This school district is home to several schools named after prominent Black leaders in our country's history as well as Atlanta, Georgia history; and these schools each have greater than 90 percent Black student enrollment. The district has piloted a cutting-edge signature K-12 program for STEM and STEAM education.

Through community partnership with Georgia Tech, this school district is able to provide AP Computer Science courses to their students spearheaded by equity in computing initiatives. Furthermore, other programs and workshops at Georgia Tech have proven instrumental to the STEM development of students at this district through various STEAM-focused summer camps that expose students to different STEM/STEAM topics. In this urban school district, brotherhood is emphasized among the Black males, and there is an elevated level of attention on evolving Black females into STEMinists, defined as anyone fighting for representation of women in STEM.

Theme 1: Accountability. At School 1, accountability is taught and shifted towards the students while teachers are facilitators of accountability. Accountability within this context refers to personal responsibility and not test-based accountability, whereby standardized tests are used as a tool for assessing school and teacher performance. Accountability productively trickled down as the class of 2020 valedictorian, salutatorian, and STAR[4] student all participated in the school's STEAM program. According to Leader 1, when it comes to educational accountability,

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[4] STAR Student and Teacher Guidelines (2021)

everything is included. “Those parents trust me with their [kids’] lives. If I don’t give them what they need, then I’ve failed them and the system that I work in. If we don’t have accountability for ourselves [as school leaders], then we won’t have it for our students.” From the vantage point of Leader 1, internal accountability at School 1 and the district as a whole works as follows: *Teachers* accountable to *Content Lead* accountable to *Department Chair* accountable to *Instructional Coach* accountable to *Assistant Principal* accountable to *Principal*.

Theme 2: School and Community Mechanisms. According to Leader 1, the cluster for School 1 experiences a severe drop off in middle school, in terms of facilitating the STEM success of Black boys and girls. There is a dearth of STEM educational alignment for these students at the middle school level with no consistent linking of successful STEM coordination from elementary school to middle school to high school. In contrast to School 1, the cluster for School 2 has a steadier STEM pipeline from elementary to middle to high school. The newly appointed principal at School 2 understands the critical nature of a healthier vertical alignment. As a result, School 2 has worked closely with the elementary and middle schools in terms of their STEM curriculum, which largely revolves around environmental science and agricultural urban sustainability.

School 1 has engaged in a partnership with a major music label that once claimed artists such as *Frank Sinatra,* the *Beatles*, and *Migos*. At a part of this partnership, the school hosts a 10-week after school program where students interact with executives of the record company to learn about the core facets of the music industry. Internships at this record label eventually come available to some students in fields such as marketing and music engineering. As students complete these internships they are able to correspond with famous artists of the label who they admire. More recently, a music artist—unrelated to the aforementioned record label—filmed a

hip hop music video inside of School 1. Having STEM/STEAM program students participate in a main stream music video has effectively functioned as a motivational tool for working hard to attain high achievement in STEM, whether it be through the school's music technology program or general math or science. This is an example of implementation of the eighth concept of the anti-deficit achievement framework—known as *possible sevles theory*—which involves the encouraging experiences of Black students who ultimately envision themselves earning a living in a STEM career.

At School 1, computer science and music technology outcomes are broken out by gender. The girls are more apt to thrive in coding software, while the boys have an increased likelihood of succeeding in the scientific creation of music. According to Weeden et al. (2020), young women are less likely than young men to earn a college degree in a STEM field even though they are more likely to attend and complete college in general (p. 1). This literature is manifested at School 2, where the girls are more well-rounded in their education—posting higher graduation rates—and the boys tend to be more involved in STEM with greater attainment in these subjects. This also reflects an obvious gender opportunity gap with origins beginning at the elementary level (Ertl et al., 2019, p. 6).

Leader 2 expounded on how School 2 has recently transitioned from a cohort model to school-wide STEM exposure to ensure all students have an enhanced math and science experience. The STEM Leadership Team at School 2 is steadfastly working toward gradual improvement of the school's STEM program and professional learning opportunities for teachers providing STEM instruction. Local HBCUs are key in stimulating the interests of students at School 3 through various programming initiatives. According to Leader 4, however, there are challenges with community and parent engagement at School 4 due to socioeconomic status

alone. “Being in Atlanta, we’re not short of programs or people who want to help, but some schools are not poised for partnership!” he or she utters emphatically with commentary about schools serving mostly Black students.

Theme 3: Recruitment and Retention. In an effort to recruit and retain highly qualified teachers of STEM at School 1, the principal makes a concerted effort to build the leadership by hiring from within. This principal has also increased the requirements for teacher experience in an urban setting. Meanwhile, at School 4, certain areas of the STEM program have not been able to get off the ground. This is indirectly a result of not having mechanisms in place to recruit and retain highly qualified teachers of STEM, according to Leader 4. He or she adds, “We have to have a better process in place to recruit high quality teachers, and we have to be a place where a high quality person would want to come and work.”

Theme 4: Pedagogical Practices. At School 4, there is not a systematic way the school implements cultural education practices. Instead, it differs from teacher to teacher. School 1 intentionally places an emphasis on cultural education practices while heavily centering their pedagogy on individuality. Leader 1 brings awareness to his or her students by underscoring the imperative nature for them to work harder as aspiring Black intellectuals. Leader 1 quoted, “I teach the Black students that ‘[while] your skin color is in front of you, it does not define you—*you* define who you are!” Similarly, Leader 1 discourses, “Sometimes your education gets you through the door—but it’s *you* who earns the job,” with reference to the traditionally marginalized students of School 1 one day joining the global workforce after completing their schooling.

“Our students’ backgrounds dictate the lens from which we need to be teaching,” Leader 2 cites with reference to School 2 being 99 percent Black with 100 percent of students receiving

free or reduced price lunch (FRPL). School 3 is similarly 99 percent Black with 100 percent of students receiving FRPL according to Leader 3. In terms of the cultural education practices at this school, the concept of each students helping one another succeed is above all. Working hard together is fundamental to success, and togetherness is ardently cultivated. This is an example of the application of the first concept of the anti-deficit achievement framework—known as *cultural capital and social capital theories*—where an anti-deficit focus is used to understand how high achieving minority students overcome socioeconomic challenges.

At School 2, culturally relevant, responsive, and sustaining pedagogies are geared more toward the school's special education population. Likewise, specific pedagogy for students with disabilities is immensely important for School 5 according to Leader 6. Moreover, Leader 6 disparages the fact that science curriculum is traditionally exclusive to dead White men. As a result, students of School 5 often feel disconnected from the curriculum. This has motivated the leaders of School 5 to advocate for the voices of Black and Brown contributors to science in spite of their voices not being highlighted in textbooks at comparatively similar levels. At School 5, legendary Black woman Henrietta Lacks is a consistent topic of discussion in science classes, and the Tuskegee Syphilis Study is referenced as an example of why African Americans are hesitant about taking a COVID-19 vaccine considering the overall distrust of science and medicine by the Black community.

School Leader 7, School 6. Leader 7 works at a neighboring Metro Atlanta school system but possesses a unique perspective as a White non-Hispanic alum of School 6 and Georgia Institute of Technology. Leader 7 graduated from Georgia Tech in three years and knew he or she wanted to be a K-12 teacher by the end of year two. Leader 7 currently serves as Director of a STEM-focused Magnet school within School 6—a school he or she has worked at

for 14 years. School 6 was the first school to receive STEM certification by the Georgia Department of Education (GaDOE) in 2012. The Magnet school has a predominantly Black student population.

To Leader 7, accountability means to ensure that every student has open opportunities for what comes next in terms of their education. “We need to be STEM literate to be leaders in whatever field we’re a part of,” Leader 7 tells his or her students with frequency. Internal accountability at School 6 is measured by the following key criteria: (1) state standardized tests, the Georgia Milestones Assessment System—End-of-course scores; (2) Advanced Placement performance; (3) college entrance exams—ACT and SAT; (4) in-school student achievement—grades and academic support; and (5) extracurricular involvement—either academic, social, community, or athletics, with a leadership role in either of these segments.

Presently, 100 percent of the Magnet school graduates go to a four-year college with over 70 percent leaving the state. Nationally recognized universities like Stanford and Vanderbilt have intimate familiarity with the Magnet program as they consistently recruit students from this program on an annual basis. This adds an additional layer of accountability for Leader 7 to find scholarship money and opportunities for his or her graduates. Recent racial demographics of the Magnet school at School 6 consists of the following: 61 percent Black, 20 percent White, nine percent Hispanic, six percent Asian, and four percent two or more races. The gender composition includes the following: 58 percent female and 42 percent male—a rare composition for a STEM school. While the assistant director of the Magnet school is African American, the faculty as a whole is majority White who serves majority underrepresented groups.

For the Magnet school graduates who matriculate at Georgia Tech, Leader 7 enthusiastically advises them, “It is going to challenge you, it is going to be hard, but you will be

better for it. STEM is hard for everyone!" He or she speaks affectionately of the experiences and the opportunities provided by Georgia Tech inside and outside of the classroom. As the only non-Black participant in this study and this dissertation, Leader 7 has a great appreciation for STEM K-12 programming that enables Black boys and girls to succeed and maybe eventually enroll at Georgia Tech in a STEM degree program.

Conclusion. In summary, the large urban school system in Metro Atlanta is working diligently to provide the predominantly Black student population it serves with enhanced opportunities to thrive in science, technology, engineering, and mathematics. STEM funding at this large urban school system is allocated annually based on the phase that each school is able to graduate to, which is based on the STEM certification process used by GaDOE to validate high quality STEM and STEAM education programs. According to Leader 1, the earliest phase includes the smallest budget for STEM operations, which is also used to fund a part-time coordinator. The next two phases include doubling or tripling of the budget to fund STEM operations and pay for the salary and benefits of a full-time coordinator of the program. The final phase is typically accompanied by an assistant to the coordinator, STEM/STEAM Certification from the state of Georgia, and partners willing to make frequent donations to the program.

School 2 is at an advanced phase and currently progressing toward acquiring their first STEM/STEAM certification. Moreover, they are working toward giving students the opportunity to pursue dual pathways in STEM. At School 3, their goal is to have 100 percent of student participating in internships with their community partners, and they are currently at 60 percent. STEM programming at School 3 revolves around the community. Students complete their own research pertaining to community and school issues and project ideas are often formulated around these prevalent issues. Actively brainstorming to provide solutions to their everyday

problems is empowering to the students of School 3 according to Leader 3.

"It's the sexy thing right now to want to help black kids," Leader 4 articulates. He or she feels responsible for remaining judicious about the experience or programs that potential partners offer as many of them are not equipped to deliver on those promises. Overall, the school leaders within this urban school system are committed to elevating the Black students at their schools as scholars and as people.

Summary

In summary, this chapter explicates the enablers of STEM persistence and high academic achievement for Black alumni and students of Georgia Tech. It thematically analyzes their K-12 journey to Georgia Tech as well as their experiences at the exclusive institution. Furthermore, this chapter evaluates Black representation and achievement in STEM at high schools in seven Metro Atlanta school districts. Finally, this chapter explores the mechanisms that enable school success in STEM at a large urban school district with over 90 percent Black student enrollment.

The questions that guided the study were (1) What are enablers of persistence and success for Black students and alumni of Metro Atlanta high schools who major in a STEM field at Georgia Institute of Technology? (2) What were the extent and variations of representation and achievement in STEM for Black students in Metro Atlanta high schools? (3) What were the extent and variations of disparities within both representation and achievement? (4) What do administrators and teachers identify as successful mechanisms that facilitate quality STEM education in Metro Atlanta schools for Black students in grades 9 through 12?

The final chapter will address the research questions that aided the investigation of enablers of STEM success of accomplished African American alumni and students of Georgia Tech. Furthermore, responses to research questions surrounding administrator and teacher

perceptions of successful K-12 STEM programming will be uncovered. The final chapter will also reference the literature review and its connection to findings of this study as well as implications of the research in this study.

CHAPTER 5

DISCUSSION, IMPLICATIONS, CONCLUSIONS

Summary of Findings

The purpose of this study was to examine the individual factors that promote high attainment for Black men and women in STEM beyond high school, assess high achievement and representation of Black high school students in STEM, and explore mechanisms and resources enabling school success in STEM. The researcher focused on an urban metropolis that is largely inhabited by African Americans and features a prominent STEM-oriented university located in the center of the municipality. The STEM university, Georgia Institute of Technology, is considered a top 10 public research university (About Georgia Tech, n.d.). This study was guided by the following research questions:

1. What are enablers of persistence and success for Black students and alumni of Metro Atlanta high schools who major in a STEM field at Georgia Institute of Technology?
2. What were the extent and variations of representation and achievement in STEM for Black students in Metro Atlanta high schools?
3. What were the extent and variations of disparities within both representation and achievement?
4. What do administrators and teachers identify as successful mechanisms that facilitate quality STEM education in Metro Atlanta schools for Black students in grades 9 through 12?

This chapter includes an analysis of the data collected from interviews and quantitative exploration. Likewise, it addresses the research questions that aided the investigation of enablers

of STEM success of accomplished Black alumni and students of Georgia Institute of Technology. Furthermore, responses to research questions surrounding administrator and teacher perceptions of successful K-12 STEM programming are revealed.

Research Question 1

Interviews of Black Georgia Tech alumni and students majoring in STEM answered the first research question. The interview protocol examined the K-12 journey to Georgia Tech for these participants as well as their experiences at the exclusive institution. Data collected and analyzed led to the emergence of the following themes:

1. Advocacy plays a major role in the STEM academic elevation of Black students, whereby specific school leaders contribute to their success by advocating for advanced coursework.
2. Cultural education practices can lead to success but are not required for Black students to be successful in STEM; and project-based learning is a direct contributor to STEM achievement for Black students.
3. Increased school and teacher expectations as elite performing students in STEM motivates and inspires students to perform well.
4. Though required, standardized testing in non-STEM subjects can disinterest elite-performers in math and science and devalue STEM in general.
5. College readiness or related programs can facilitate STEM success for Black students in STEM.
6. Being Black at a predominantly White institution can be challenging, but minority educational programs can elevate Black students above isolation by connecting them with other minority high achievers on college campuses.

7. School culture and school and teacher expectations at exclusive universities can challenge the fortitude of high STEM achievers, but ultimately drive them to persevere and achieve.

Research Question 2

A quantitative descriptive analysis was completed to answer the second and third research questions. Atlanta Public Schools (APS), the district serving the highest percentage of Black students, had close to the lowest student pass rate on Advanced Placement (AP) tests in Computer Science, Biology, and Chemistry over a five-year period. Fulton County Schools (FCS) experienced the highest pass rate for both AP Calculus A and Calculus BC of the seven school districts evaluated in this study. FCS also had the highest pass rate for AP Computer Science A, Physics 1, Physics 2, and Chemistry—more than half of the subjects analyzed.

Research Question 3

Highest Black student enrollment and corresponding high achievement in AP Calculus and AP Physics 1 notwithstanding, APS posted the largest Black-White achievement gap between distinguished performing students on standardized math and science tests. Specifically, as it pertains to representation, Cobb County School District and Gwinnett County Public Schools had the lowest percentage of Black students tested at 33.3 and 33.9 percent, respectively, in end-of-year standardized assessments in math and science. However, neither district had the narrowest Black-White achievement gap over a five-year period. Douglas County School System and Henry County School District, both with 55.6 percent of Black students tested, had the smallest achievement gaps.

Research Question 4

Interviews of school leaders who teach or coordinate STEM programs in Metro Atlanta answered the fourth research question. The interview protocol examined their experiences with

promoting and implementing components of quality education in STEM, particularly for Black students. Data collected and analyzed led to the emergence of the following themes:

1. While teachers are accountable to students, parents, and administrators—the latter of which who are accountable to the school district—teaching and shifting accountability to students can push them to the top of their class.
2. Internal district alignment between elementary, middle, and high schools in addition to external partnerships with members of the community can facilitate STEM engagement and achievement for Black students.
3. Building leadership within schools serving predominantly Black students and increasing requirements for teacher experience in urban settings can assist in recruiting and retaining highly qualified teachers of STEM.
4. Cultural education practices come in many forms and can be used to connect with different subgroups of students to link math and science content and inspire high academic achievement.

Discussion

Black GT STEM Atlanta

STEM Advocacy. There is an unambiguous correlation between high academic achievement in STEM for Black students and advocacy from K-12 school leaders who recognized their unique abilities. Using the anti-deficit achievement conceptual framework, the researcher directly inquired about enablers of success, and most of the participants mentioned that a K-12 teacher or administrator recognized their STEM talent and advocated for advanced coursework. The anti-deficit achievement concept, *attribution theory*, is on full display here as these students from historically disenfranchised groups identify attributors to their academic

achievement. Once an advocate observed their advanced understanding of math and science content, these Black and talented students were placed in gifted education programs. Previous literature—detailing how gifted programs in elementary and middle schools prepare Black students to succeed in STEM at secondary and postsecondary levels—accurately predicted the long-term STEM success of the participants in this study (Crabtree et al., 2019, p. 204).

Pedagogy. The data collected in these interviews is evidence of positive effects of cultural education practices on educational outcomes of underrepresented minority students. This finding is confirmed by previous literature pointing to the benefit of schools and education practitioners invoking cultural education practices as this implementation can lead to female students and students of color remaining in the K-20 STEM educational pipeline (Stevens et al., 2016, p. 948). Conversely, the absence of exposure to these practices does not unequivocally result in poor academic performance.

Project-based learning, or *doing* science, is an effective form of pedagogy that incited the curiosity of all 16 participants and inspired them to dig deeper intellectually. By engaging in project-based learning activities and actively exploring real-world phenomena, students can come to understand the nature of scientific discovery as opposed to viewing science as abstract facts. While all of the participants of this study are Black, their success with hands-on scientific learning is a microcosm into the nation's entire student population. All students benefit greatly from this type of instruction as research supports student in-depth participation as a fulcrum to their development of science content knowledge (National Academies of Sciences, 2015a, p. 29).

Intersectionality in STEM. Precisely half of the participants in the first phase of this study of Black alumni or students of Georgia Tech are women. As such, their intersectional experiences in STEM at a White, male majority university are unique relative to others. This

double intersectionality—and even triple for one participant who is also gay—occasionally led to feelings of isolationism, particularly while at Georgia Tech. Two participants specifically experienced direct neglect from classmates because they are Black and female. These situations confirm literature that references the alienation felt by Black women in STEM environments and why they are grossly underrepresented (Charleston et al., 2014; Sparks, 2017). Girls of color disproportionately require gender responsive pedagogy and instruction in settings that highlight STEM due to persistent gender and racial marginalization in these fields (Young, Young, & Paufler, 2017).

School Organization. The experiences of the 16 participants confirmed that the organization of schools—school culture and school and teacher expectations—drives STEM success for high achieving Black students. Within the context of the conceptual framework chosen for this study, these participants cited school culture inspiring their development of confidence in STEM subjects (Harper, 2010; Harper 2012). Additionally, having high expectations imparted on them during their secondary and postsecondary experiences pushed them to higher heights academically, thus confirming established literature that positive expectations by teachers and schools are needed in order to effectively educate traditionally marginalized students (Lee & Bryk, 1989). When school and teacher expectations are high and when school culture involves consistently arduous course work, metaphorical diamonds are created. However, the pressure created by schools and school leaders can also provoke students to drift away academically and opt for easier pathways. In some instances, students are tasked with overcoming low educational standards at their schools in an effort to achieve high academic success.

Standardized Testing. Most of the participants in this study lamented the fact that standardized assessments were daunting and ineffective at stimulating their STEM interests. This evidence supports previous studies that determined that preparing Black students for the math and science sections of standardized tests can disinterest the ones that are mathematically and scientifically gifted (Wright et al., 2015). In contrast, college readiness or related programming enhanced the STEM interests for some but was not a requirement for others who remained persistently involved in STEM.

Additional Takeaways. Another interesting takeaway is IBM being an employer of influential parents or grandparents for three of the participants in this study. Additionally, an unanticipated takeaway is that three of the non-Computer Science majors enjoyed coding, and one of the three currently works in the computer coding profession while another is pursuing his Master's degree in Computer Science. The latter recognized that his specific engineering degree is particularly concentrated in terms of his career opportunities, and so he seeks to expand his options as a professional. Overall, instead of taking a deficit-oriented approach that emphasizes the barriers faced by the study participants—to include focuses on being first-generation college students, coming from lower socioeconomic backgrounds, and lacking educational cultural capital—this case study used an ant-deficit achievement framework to uncover enablers of persistence and success in STEM.

K-12 STEM Access and Achievement

Primary contributing factors to Black-White achievement gaps in STEM consist of inequalities in socioeconomic status (SES) as many Black students derive from lower-income households and attend lower-quality schools in communities absent of educational resources (Riestra et al., 2019). The quantitative descriptive analysis completed in this study adds

dimension to this literature as the Black-White achievement gap in math and science is most conspicuous in Atlanta Public Schools (APS)—the school district serving the highest proportion of Black students by a wide margin. Furthermore, at most of the secondary schools in APS, 100 percent of students receive free or reduced price lunch. When controlling for SES, gaps are narrowed due to the strong correlation between race and socioeconomic status although these racial gaps still exist in a major way (Curran & Kellogg, 2016, p. 280).

Mechanisms Enabling School Success

Accountability is paramount in schools, and teachers are often agents of accountability. Accountability within this context refers to personal responsibility and not test-based accountability, whereby standardized tests are used as a tool for assessing school and teacher performance. When effectively implemented, accountability can lead to promising academic outcomes, particularly for Black students in STEM in an urban environment (Rodriguez, 2006). In addition to being accountable to student outcomes, teachers are often accountable to school administrators, parents of students, and the community. The researcher was surprised to hear how frequently accountability flows only one direction, from the top down; and the mechanisms in place to evaluate from the bottom-up are too often not trustworthy.

Partnerships between K-12 schools and communities go a long way in facilitating the STEM engagement of Black students. Giving these students opportunities to correspond with community leaders and participate in workshops and summer camps at local colleges and universities is instrumental in keeping them in the STEM educational pipeline. The National Research Council (2011) states that not only will these students have an increased likelihood of remaining in the STEM educational pipeline, but they are also more likely to earn a STEM degree and succeed in a STEM profession. According to the anti-deficit achievement theoretical

perspective, outliers in STEM have a list of resources responsible for their achievements (Harper, 2010; Means & Coleman, 2018). Community partnerships proved to be a valuable resource for the participants of this study.

This study is confirmation of the need for highly qualified teachers (HQT) of STEM as quality STEM education requires recruiting, preparing, developing, and retaining quality STEM teachers (Wilson, 2009, p. 1). In order to maximize their effectiveness as STEM educators, high quality teachers need expansive knowledge and ongoing professional development training in STEM subject content (Young, Young, & Paufler, 2017). Moreover, this study highlights the value of teacher experience working in an urban setting. HQTs are able to successfully cultivate environments of camaraderie and togetherness. Furthermore, they are able to tailor instruction in a culturally relevant, responsive, or sustaining manner to link math and science content to student experiences and promote high academic attainment. An example referenced in literature is teachers requiring students to research issues within their community and develop scientific strategies for resolution (King, 2017; Tate, 1995, p. 170).

Implications

Implications for Research

The findings of this study suggest that further research is needed to determine how school and teacher expectations are operationalized in K-12 schools, explicitly for Black students in STEM. This research could identify what enables and hinders access and achievement, directly effecting disparities in representation and achievement in STEM. Another implication for research is to contrast the findings of this study with previous literature on policies and programs in Black schools across the nation. Freeman (2007) states that the proportion of Black students in school is a leading predictor of the variety of programs offered at schools. Understanding

whether or not this is true in large urban school systems like APS could help policymakers determine the benefits these programs have on the academic outcomes of Black students in STEM.

Considering three of the Black alumni or students of Georgia Tech who participated in this study had an influential parent or grandparent who previously worked for IBM, further research is needed to examine the employment opportunities provided by this tech tycoon for African American in the South. Perhaps this corporation inspired intergenerational interest in STEM for Black families, which can ultimately lead to the narrowing of access and achievement gaps? Examining the success of the aforementioned participants in this study, and the 13 others, exclusively through the lens of the *portraiture* theoretical perspective is another implication for research. Sara Lawrence-Lightfoot has brilliantly pioneered this conceptual framework—a social scientific investigative approach that blends art and science (Lawrence-Lightfoot & Davis, 1997).

One final implication for research includes thorough inquiry into the positive implications of two of the six colleges at Georgia Tech being led by Black men. Drs. Charles Isbell and Raheem Beyah are the deans of the College of Computing and College of Engineering, respectively. Both are from Atlanta and attended schools in APS. Considering their academic and professional ascension in STEM, a case study analyzing their impact on other African Americans in STEM from Atlanta and the present-day pipeline of the K-12 school clusters they attended could provide tremendous insight into enablers of success in STEM. Such a case study, could have a reverberating impact on STEM policy for all urban school districts with STEM-oriented universities within close proximity. It is important to note that Black students with STEM aspirations do not have to attend K-12 schools in Metro Atlanta or enroll at Georgia Tech

to be successful in STEM. However, these two components—or the intersection thereof—have proven to create compounding benefits in the pursuit of a STEM degree and a subsequent career in a STEM field.

Implications for Policy

Considering the Fall 2020 enrollment demographics at Georgia Tech reveal that Black students represent only six percent and four percent of all majors at the College of Engineering and College of Computing, respectively, increasing Black enrollment in STEM majors at the intuition is paramount (Student Enrollment, n.d.). As such, an implication for policy involves elevated emphasis of equity-based evaluations, in terms of admissions decisions for Black students aspiring to matriculate at Georgia Tech. Likewise, a constant review of equity-based scholarship opportunities should be considered with the goal of increasing the enrollment of Black students at Georgia Tech in STEM degree programs. While the participants of this study that are graduates of—or currently enrolled at—Georgia Tech have proven to be academic outliers as Black STEM scholars, their aberrant success highlights the need for policy to increase Black enrollment at this prestigious university. In 2020, the prestige of Georgia Tech was recognized by U.S. News and World Report who ranked the institution in the top ten of public colleges or universities in the U.S. (Georgia Institute of Technology, 2021).

Considering the geographical benefit of Georgia Tech being located at the center of a Black metropolis, and the university's pathway programs created to elevate STEM opportunities of K-12 students attending local schools, perhaps policy should be in place across the nation with similar setups. Maybe these policies are already in place in other urban municipalities. If not, a STEM-focused university like California Institute of Technology, for example, could enhance K-12 access to STEM in Los Angeles County, California—a metropolis with mostly minority

populations.

Policy should be enacted to address the many Black youths who are gifted in STEM but often forgotten. Where advocacy is not available to this intelligent group of students, instruments that measure progress and proficiency are of the utmost importance. These instruments might include, but are not limited to, selective testing of understanding of advanced level math and science concepts or implementation of more pull-out programs for Black students recognized as gifted by state standardized testing metrics.

Seymour and Hewitt (1997) asserted that Black students intellectually bound by over-confidence and poor preparation often come from poorer schools and subsequently are at risk of changing their STEM major or withdrawing from school altogether. While this may be true, perhaps the greatest cause of Black students becoming over-confident and consequently falling from the STEM educational pipeline is the lack of financial resources to employ highly qualified teachers of STEM at their schools. This is why it's important to constitute policy that provides teachers of STEM compensation that is comparable to jobs in the private sector and commensurate with their credentials.

Conclusions

Some of the participants mentioned the contributions of their mothers to their STEM success with no mention of their fathers. There were others who mentioned their fathers during interviews, but in some instances, that information was not relevantly transcribed and added to this research study. Generally, parents and family members were incredibly instrumental in the early STEM successes of all participants to varying degrees. This finding affirms literature that parents and relatives play an integral role in introducing students to STEM and cultivating their ideas and understandings (Wright et al., 2015).

The findings of this dissertation indicate that Black STEM excellence often begins early during the adolescent years of the STEM journey of Black boys and girls. Their flair for science, technology, engineering, and mathematics is then cultivated and complimented by influential people and community resources. Though these resources are not exclusive to large local metropolitan cities, they are often most available in these localities.

In terms of community resources available in urban vicinities, Atlanta, Georgia has a plethora of resources available to promote interests and enhance academic achievement in STEM for Black children, to include Children's Museum of Atlanta and STEAMsport, Inc. to name a few. Hands-on exhibits designed to stimulate inventive and creative thinking for children as early as toddlers is instrumental at developing higher-order reasoning functions of children within an engineering design framework. Lastly, a lasting takeaway for the researcher from this study is that cultural education practices come in many forms; and sometimes it's a simple as a physical or cultural resemblance of teachers, professors, and mentors to students.

REFERENCES

About Georgia Tech. (n.d.). Georgia Tech; Georgia Institute of Technology. Retrieved June 24, 2021, from https://www.gatech.edu/about.

African American Experience. (n.d.). National Park Service, Atlanta: A National Register of Historic Places Travel Itinerary. Retrieved May 31, 2021, from https://www.nps.gov/nr/travel/atlanta/africanamerican.htm.

APS Scholars. (n.d.). Undergraduate Admission; Georgia Institute of Technology. Retrieved May 18, 2021, from https://admission.gatech.edu/aps.

Atlanta Public Schools (APS) Pathway Program. (n.d.). Undergraduate Admission; Georgia Institute of Technology. Retrieved May 18, 2021, from https://admission.gatech.edu/aps-pathway.

Atwater, M. M., Freeman, T. B., Butler, M. B., & Draper-Morris, J. (2010). A Case Study of Science Teacher Candidates' Understandings and Actions Related to the Culturally Responsive Teaching of 'Other' Students. *International Journal of Environmental & Science Education, 5*(3), 287-318. Retrieved from https://eric.ed.gov/?id=EJ895740.

Burke, L. M., & McNeill, J. B. (2011). "Educate to Innovate": How the Obama Plan for STEM Education Falls Short. In *Backgrounder* (2504th ed., pp. 1–8). Washington, DC: The Heritage Foundation.

CAU History. (n.d.). Clark Atlanta University. Retrieved May 31, 2021, from https://www.cau.edu/history.html.

Cazden, C. B., & Leggett, E. L. (1976). Culturally Responsive Education: A Response to LAU

Remedies II. Retrieved from https://eric.ed.gov/?id=ED135241.

Charleston, L. J., Adserias, R. P., Lang, N. M., & Jackson, J. F. (2014). Intersectionality and STEM: The Role of Race and Gender in the Academic Pursuits of African American Women in STEM. *Journal of Progressive Policy & Practice, 2*(3), 273-293.

Chow, A. R. (2020). *A History of the Black National Anthem*. Time; Time. https://time.com/5864238/black-national-anthem/

Clarke, M. (2007). State Responses to the No Child Left Behind Act: The Uncertain Link between Implementation and "Proficiency for All". In C. F. Kaestle & A. E. Lodewick (Eds.), *To Educate a Nation: Federal and National Strategies of School Reform* (pp. 144-174). Lawrence, KS: University Press of Kansas.

Colbert, P. J. (2010). Developing A Culturally Responsive Classroom Collaborative of Faculty, Students, And Institution. *Journal of College Teaching & Learning (TLC), 7*(11). doi:10.19030/tlc.v7i11.247.

Cook-Sather, A., & Agu, P. (2013). Student Consultants of Color and Faculty Members Working Together Toward Culturally Sustaining Pedagogy. *To Improve the Academy, 32*(1), 271-285. doi:10.1002/j.2334-482 2.2013.tb00710.x.

Course Requirements by Major. (2019). Undergraduate Admission; Georgia Institute of Technology. https://admission.gatech.edu/sites/default/files/images/course_requirements_chart_april_2019.pdf.

Crabtree, L. M., Richardson, S. C., & Lewis, C. W. (2019). The Gifted Gap, STEM Education, and Economic Immobility. *Journal of Advanced Academics, 30*(2), 203-231. doi:10.1177/1932202x19829749.

Criterion-Referenced Competency Tests (CRCT). (2021). Georgia Department of Education. https://www.gadoe.org/Curriculum-Instruction-and-Assessment/Assessment/Pages/CRCT.aspx.

Curran, F. C., & Kellogg, A. T. (2016). Understanding Science Achievement Gaps by Race/Ethnicity and Gender in Kindergarten and First Grade. *Educational Researcher*, *45*(5), 273–282. doi: 10.3102/0013189x16656611.

Dee, T., & Jacob, B. (2010). Evaluating NCLB: accountability has produced substantial gains in math skills but not in reading. *Education Next*, *10*(3), 54+. https://link.gale.com/apps/doc/A245037871/AONE?u=gauniv&sid=googleScholar&xid=2ecbd926.

Deiglmayr, A., Stern, E., & Schubert, R. (2019). Beliefs in "Brilliance" and Belonging Uncertainty in Male and Female STEM Students. *Frontiers in Psychology, 10*, 194-200.

Diekman, A. B., Weisgram, E. S., & Belanger, A. L. (2015). New Routes to Recruiting and Retaining Women in STEM: Policy Implications of a Communal Goal Congruity Perspective. *Social Issues and Policy Review*, *9*(1), 52–88.

Dual Degree Options. (n.d.). Georgia Tech College of Engineering; Georgia Institute of Technology. Retrieved May 25, 2021, from https://coe.gatech.edu/future-engineers/dual-degree-options.

EarSketch. (n.d.). Georgia Institute of Technology. Retrieved June 1, 2021, from https://earsketch.gatech.edu/.

Ertl, B., Luttenberger, S., Lazarides, R., Jones, M. G., & Paechter, M. (2019). Gendered Paths into STEM. Disparities Between Females and Males in STEM Over the Life-Span. *Frontiers Research Topics, 10*, 6-9. doi:10.3389/978-2-88963-439-2.

Fayer, S., Lacey, A., & Watson, A. (2017). STEM Occupations: Past, Present, And Future. Retrieved from https://www.bls.gov/spotlight/2017/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future/pdf/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future.pdf.

Figlio, D. N. (2003). *Testing, crime and punishment*. Cambridge, MA: National Bureau of Economic Research.

Fox, M. (2005). *William A. Bootle, Judge in Desegregation Case, Dies at 102*. The New York Times. https://www.nytimes.com/2005/01/27/us/william-a-bootle-judge-in-desegregation-case-dies-at-102.html.

Freeman, K. E. (2007). Policies and Programs in the Nation's Black High Schools: Are They Evidence-Based? In C. F. Kaestle & A. E. Lodewick (Eds.), *To Educate a Nation: Federal and National Strategies of School Reform* (pp. 225–251). University Press of Kansas.

Fried, R. L. (2005). *The Game of School: Why We All Play It, How it Hurts Kids, and What it Will Take to Change It*. San Francisco, CA: Jossey-Bass Education.

Gay, G. (2000). *Culturally Responsive Teaching: Theory, Research, and Practice*. New York: Teachers College Press.

Georgia Institute of Technology. (2021). U.S. News & World Report. https://www.usnews.com/best-colleges/georgia-institute-of-technology-1569/overall-rankings.

Georgia Milestones Assessment System. (2021). Georgia Department of Education. https://www.gadoe.org/Curriculum-Instruction-and-Assessment/Assessment/Pages/Georgia-Milestones-Assessment-System.aspx.

Georgia Tech Scholars Program. (n.d.). Undergraduate Admission; Georgia Institute of Technology. Retrieved May 18, 2021, from https://admission.gatech.edu/gtscholars.

Harper, S. R. (2010). An Anti-Deficit Achievement Framework for Research on Students of Color in STEM. *New Directions for Institutional Research*, *2010*(148), 63–74. doi: 10.1002/ir.362.

Harper, S. R. (2012). Black Male Student Success in Higher Education: A Report from the National Black Male College Achievement Study. Retrieved from https://web-app.usc.edu/web/rossier/publications/231/Harper (2012) Black Male Success.pdf.

History of GT Computing. (2020). College of Computing; Georgia Institute of Technology. https://www.cc.gatech.edu/about/history.

Hoferichter, F., & Raufelder, D. (2019). Mothers and Fathers—Who Matters for STEM Performance? Gender-Specific Associations Between STEM Performance, Parental Pressure, and Support During Adolescence. *Frontiers in Education, 4*, 65-74.

Hsieh, T., Liu, Y., & Simpkins, S. D. (2019). Changes in United States Latino/a High School Students' Science Motivational Beliefs: Within Group Differences Across Science Subjects, Gender, Immigrant Status, and Perceived Support. *Frontiers in Psychology, 10*, 53-64.

Huber, T. (1991). Restructuring To Reclaim Youth at Risk: Culturally Responsive Pedagogy. Retrieved from https://eric.ed.gov/?id=ED341655.

Hutchison, L. F. (2012). Addressing the STEM Teacher Shortage in American Schools: Ways to Recruit and Retain Effective STEM Teachers. *Action in Teacher Education, 34*, 541-550. doi:10.1080/01626620.2012.729483.

Ingersoll, R. M. (2003). Is There a Shortage Among Mathematics and Science Teachers? *Science*

Educator, 12(1), 1-9.

Johnson, N. H., & Atwater, M. M. (2013). The Impact of Beliefs and Actions on the Infusion of Culturally Relevant Pedagogy in Science Teacher Education. *Multicultural Science Education,* 81-102. doi:10.1007/978-94-007-7651-7_6.

Jungert, T., Hubbard, K., Dedic, H., & Rosenfield, S. (2018). Systemizing and the Gender Gap: Examining Academic Achievement and Perseverance in STEM. *European Journal of Psychology of Education, 34*(2), 479-500. doi:10.1007/s10212-018-0390-0.

King, N. S. (2017). When Teachers Get It Right: Voices of Black Girls' Informal STEM Learning Experiences. Retrieved from http://scholarworks.sfasu.edu/cgi/viewcontent.cgi?article=1029&context=jma.

Koerting, K. (2018). *More Women Than Men in Life Sciences but Less in STEM*. NewsTimes; News Times. https://www.newstimes.com/local/article/More-women-than-men-in-life-sciences-but-less-in-12777665.php.

Ladson-Billings, G. (1995a). Toward a Theory of Culturally Relevant Pedagogy. *American Educational Research Journal, 32*(3), 465-491. doi:10.3102/00028312032003465.

Ladson-Billings, G. (1995b). But That's Just Good Teaching! The Case for Culturally Relevant Pedagogy. *Theory Into Practice, 34*(3), 159-165. doi:10.1080/00405849509543675.

Langdon, D., McKittrick, G., Beede, D., Khan, B., & Doms, M. (2011). STEM: Good Jobs Now and for the Future. ESA Issue Brief #03-11. Retrieved from https://eric.ed.gov/?id=ED522129.

Lee, V. E., & Bryk, A. S. (1989). A Multilevel Model of the Social Distribution of High School Achievement. *Sociology of Education, 62*(3), 172-192. doi:10.2307/2112866.

Lee, V. E., Smith, J. B., Perry, T. E., & Smylie, M. A. (1999). *Social Support, Academic Press,*

and Student Achievement: A View from the Middle Grades in Chicago. Chicago, IL: Consortium on Chicago School Research.

Maltese, A. V., & Tai, R. H. (2011). Pipeline Persistence: Examining the Association of Educational Experiences With Earned Degrees in STEM Among U.S. Students. *Science Education, 95*(5), 877-907. doi:10.1002/sce.20441.

Martin, R., & Inskeep, S. (Host). (2020, April 29). *U.S. GDP Report, Trump Signs Order On Meatpacking Plants, Coronavirus Lab Funding Cut* [Audio podcast]. Retrieved from https://www.npr.org/2020/04/26/845232367/u-s-gdp-report-trump-signs-order-on-meatpacking-plants-coronavirus-lab-funding-c.

Marx, R. W., & Harris, C. J. (2006). No Child Left Behind and Science Education: Opportunities, Challenges, and Risks. *The Elementary School Journal*, *106*(5), 467–478. doi: 10.1086/505441.

McKerracher, T. (2018). *A Brief History of Atari*. Back to the Gaming; Back to the Gaming. https://backtothegaming.com/the-history-of-atari/.

Means, D. R., & Coleman, R. D. (2018). Using an Anti-Deficit Achievement Approach to Examine a Black Male College Student's Pursuit of a Career in Computer Science. In L. A. Castenell, T. C. Grantham, & B. J. Hawkins (Eds.), *Recruiting, Retaining, and Engaging African American Males at Selective Public Research Universities: Challenges and Opportunities in Academics and Sports* (pp. 237–247). Charlotte, NC: Information Age Publishing, Inc.

Moss, C. (2018). Decreasing the Achievement Gap with STEM » Connections Article. Retrieved from https://www.milkeneducatorawards.org/connections/articles/view/decreasing-achievement-gap-stem-cindy-moss.

Movement for the Survival of the Ogoni People (MOSOP) and Ogoni News and Resources. (2015). Movement for the Survival of the Ogoni People (MOSOP) & Ogoni News and Resources. http://www.mosop.org/.

Muñiz, J. (2019). Culturally Responsive Teaching: A 50-State Survey of Teaching Standards. Retrieved from https://eric.ed.gov/?id=ED594599.

Nadelson, L. S., Seifert, A., Moll, A. J., & Coats, B. (2012). I-STEM Summer Institute: An Integrated Approach to Teacher Professional Development in STEM. *Journal of STEM Education, 13*(2), 69-82.

National Academies of Sciences, Engineering, and Medicine. (2015a). A New Vision of Science Teaching and Learning. In *Science Teachers' Learning: Enhancing Opportunities, Creating Supportive Contexts* (pp. 27-46). Washington, DC: The National Academies Press. doi:10.17226/21836.

National Academies of Sciences, Engineering, and Medicine. (2015b). The K-12 Science Teaching Workforce. In *Science Teachers' Learning: Enhancing Opportunities, Creating Supportive Contexts* (pp. 69-92). Washington, DC: The National Academies Press. doi:10.17226/21836.

National Academies of Sciences, Engineering, and Medicine. (2015c). Science Teachers' Learning Needs. In *Science Teachers' Learning: Enhancing Opportunities, Creating Supportive Contexts* (pp. 93-114). Washington, DC: The National Academies Press. doi:10.17226/21836.

National Academies of Sciences, Engineering, and Medicine. (2015d). Creating a Supportive Context for Teacher Learning. In *Science Teachers' Learning: Enhancing Opportunities, Creating Supportive Contexts* (pp. 175-212). Washington, DC: The National Academies

Press. doi:10.17226/21836.

National Research Council. (2011). *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*. Washington, DC: The National Academies Press.

News List. (2017). Atlanta City Council, GA. https://citycouncil.atlantaga.gov/Home/Components/News/News/296/.

No Child Left Behind (NCLB). (2019). Parent to Parent of Georgia. https://www.p2pga.org/roadmap/education/special-education-law/no-child-left-behind-nclb/.

Olszewski-Kubilius, P., Steenbergen-Hu, S., Thomson, D., & Rosen, R. (2016). Minority Achievement Gaps in STEM. *Gifted Child Quarterly, 61*(1), 20-39.

Ong, M., Smith, J. M., & Ko, L. T. (2017). Counterspaces for Women of Color in STEM Higher Education: Marginal and Central Spaces for Persistence and Success. *Journal of Research in Science Teaching, 55*(2), 206-245. doi:10.1002/tea.21417.

Pappamihiel, N. E., & Moreno, M. (2011). Retaining Latino Students: Culturally Responsive Instruction in Colleges and Universities. *Journal of Hispanic Higher Education, 10*(4), 331-344. doi:10.1177/1538192711410602.

Paris, D. (2012). Culturally Sustaining Pedagogy: A Needed Change in Stance, Terminology, and Practice. *Educational Researcher, 41*(3), 93-97. doi:10.3102/0013189x12441244.

Paris, D., & Alim, H. S. (2014). What Are We Seeking to Sustain Through Culturally Sustaining Pedagogy? A Loving Critique Forward. *Harvard Educational Review, 84*(1), 85-100. doi:10.17763/haer.84.1.982l873k2ht16m77.

Pewewardy, C. D. (1993). Culturally Responsive Pedagogy in Action: An American Indian

Magnet School. In E. R. Hollins, J. E. King, & W. C. Hayman (Eds.), *Teaching Diverse Populations: Formulating a Knowledge Base* (pp. 77-92). Albany, NY: State University of New York Press.

Puzio, K., Newcomer, S., Pratt, K., McNeely, K., Jacobs, M., & Hooker, S. (2017). Creative Failures in Culturally Sustaining Pedagogy. *Language Arts, 94*(4), 223-232.

Riestra, A. M., Morales, A. J., & Mercer, F. (2019). Targeting the Achievement Gap: Strategies Toward Removing Inequities in Undergraduate Immunology Education. *Frontiers in Immunology, 10*. doi:10.3389/fimmu.2019.02906.

Rodriguez, A. J. (2006). Building Rovers to Bridge the Achievement Gap: Space Exploration at School and at Home. *Science Education: An International Encyclopedia*.

Rozek, C. S., Ramirez, G., Fine, R. D., & Beilock, S. L. (2019). Reducing Socioeconomic Disparities in the STEM Pipeline Through Student Emotion Regulation. *Proceedings of the National Academy of Sciences, 116*(5), 1553-1558. doi:10.1073/pnas.1808589116.

Seymour, E., & Hewitt, N. M. (1997). Talking about Leaving: Why Undergraduates Leave the Sciences. *Contemporary Sociology*, *26*(5).

Solórzano, D. G., Ceja, M., & Yosso, T. (2000). Critical Race Theory, Racial Microaggressions, and Campus Racial Climate: The Experiences of African American College Students. *The Journal of Negro Education, 69*(1), 60-73. Retrieved from https://www.jstor.org/stable/2696265.

Sparks, D. M. (2017). Navigating STEM-Worlds: Applying a Lens of Intersectionality to the Career Identity Development of Underrepresented Female Students of Color. *Journal for Multicultural Education, 11*(3), 162-175. doi:10.1108/jme-12-2015-0049.

Speer, J. D. (2019). *Bye Bye Ms. American Sci: Women and the Leaky Stem Pipeline*

(dissertation).

STAR Student and Teacher Guidelines. (2021). Professional Association of Georgia Educators; PAGE INC. https://www.pageinc.org/star/star-student-and-teacher-guidelines/.

Stevens, S., Andrade, R., & Page, M. (2016). Motivating Young Native American Students to Pursue STEM Learning Through a Culturally Relevant Science Program. *Journal of Science Education and Technology, 25*(6), 947-960. doi:10.1007/s10956-016-9629-1.

Student Enrollment. (n.d.). LITE - Leading Insight Through Empowerment; Georgia Tech Enterprise Data Management. Retrieved May 18, 2021, from https://lite.gatech.edu/lite_script/dashboards/enrollment.html.

Suggs, E. (2019). *Georgia Tech to Honor Pioneering Black Students*. AJC; The Atlanta Journal-Constitution. https://www.ajc.com/news/georgia-tech-honor-pioneering-black-students/iBQFFg0NFgTw5s1FzIyVjI/.

Sunderman, G. L. (2009). Examining the Federal Role in Education: From Reagan's Excellence Movement to Bush and No Child Left Behind. In K. K. Wong & R. Rothman (Eds.), *Clio at the Table: Using History to Inform and Improve Education Policy* (pp. 182-197). New York, NY: Peter Lang Publishing Inc.

Svoboda, R. C., Rozek, C. S., Hyde, J. S., Harackiewicz, J. M., & Destin, M. (2016). Understanding the Relationship Between Parental Education and STEM Course Taking Through Identity-Based and Expectancy-Value Theories of Motivation. *AERA Open, 2*(3), 1-13. doi:10.1177/2332858416664875.

Taningco, M. T. V., Mathew, A. B., & Pachon, H. P. (2008). STEM Professions: Opportunities and Challenges for Latinos in Science, Technology, Engineering, and Mathematics. A Review of Literature. Retrieved from https://eric.ed.gov/?id=ED502063.

Tate, W. F. (1995). Returning to the Root: A Culturally Relevant Approach to Mathematics Pedagogy. *Theory Into Practice, 34*(3), 166-173. doi:10.1080/00405849509543676.

The Ogoni Nine Execution. (2019). Letstalkhistory; Letstalkhistory. https://letstalkhistory.com.ng/the-ogoni-nine-execution/.

Vinovskis, M. A. (2009). *From a Nation at Risk to No Child Left Behind: National Education Goals and the Creation of Federal Education Policy*. New York, NY: Teachers College Press.

Weeden, K. A., Gelbgiser, D., & Morgan, S. L. (2020). Pipeline Dreams: Occupational Plans and Gender Differences in STEM Major Persistence and Completion. *Sociology of Education,* 1-18. doi:10.1177/0038040720928484.

Williams, Lawrence. (2020). Civil Rights Digital Library; The Digital Library of Georgia. http://crdl.usg.edu/people/w/williams_lawrence/?Welcome.

Wilson, S. (Ed.). (2009). Teacher Quality. Education Policy White Paper. Retrieved from https://eric.ed.gov/?id=ED531145.

Wlodkowski, R. J., & Ginsberg, M. B. (1995). A Framework for Culturally Responsive Teaching. Retrieved from http://www.ascd.org/publications/educational-leadership/sept95/vol53/num01/A-Framework-for-Culturally-Responsive-Teaching.aspx.

Wright, B. L., Counsell, S. L., Goings, R. B., Freeman, H., & Peat, F. (2016). Creating Access and Opportunity: Preparing African-American Male Students for STEM Trajectories PreK-12. *Journal for Multicultural Education, 10*(3), 384-404. doi:10.1108/jme-01-2016-0003.

Young, J. L., Young, J. R., & Paufler, N. A. (2017). Out of School and into STEM: Supporting

Girls of Color through Culturally Relevant Enrichment. *Journal of Interdisciplinary Teacher Leadership, 1*(2), 28-34. doi:10.46767/kfp.2016-0010.

Zero Mile Post. (2015). Georgia Historical Society. https://georgiahistory.com/ghmi_marker_updated/zero-mile-post/.

APPENDIX A

CONSENT FORM

Georgia Tech Students and Alumni

As co-principal investigator, I, Mark Anthony Williams Jr., am writing this letter to request your participation in the research study titled, ***Enablers of Student Persistence and Success in STEM*** —one of three studies in the dissertation topic, *Race, Gender, and the Intersection Thereof in STEM: High Quality Education and Enablers of Success*. Under the guidance of major professor and principal investigator, Walker Swain, I will survey the insights of African American students and alumni of Georgia Institute of Technology who major in science, technology, engineering or mathematics and who attended high school in Metro Atlanta.

This study employs an anti-deficit achievement approach—whereby the focus is on success and not failure—to examine African American young adults to learn about their enablers of persistence and high attainment in science, technology, engineering, and mathematics (STEM). I will use semi-structured interviews with Black students and alumni of Georgia Tech, and these interviews will provide understanding of factors that motivate success. Each initial interview is anticipated to last approximately 1 hour and will be recorded.

The following points will be explained to you:

1. You will be participating in an interview in which you will be asked to describe the factors that enabled your success in STEM. These factors include, but are not limited to, the following: (1) school organization (culture, course takings, expectations), (2) pedagogy (cultural education practices, hands-on project-based learning), (3) quantity of standardized testing, (4) influential persons (support system, non-family members, school leaders), and (5) participation in college readiness programs.
2. No discomfort or stresses during the experiment are foreseen.
3. No risks are foreseen.
4. The results of this participation will be confidential and will not be released in any individually identifiable form without your prior consent unless required by law.
5. Your interview will be recorded.

Participation is entirely voluntary, and you can stop taking part without giving any reason and without penalty. You can refuse to participate or ask to have all of the information returned to you, removed from the research records, or destroyed. Further, a follow-up interview may be requested, which may take an additional 30 minutes. The purpose of this interview would be to further probe unanswered or underexplored questions and details from the initial interview.

Interviews will be conducted virtually by Zoom. To minimize risks associated with a potential breach of confidentiality, I will operate as the host to control who attends the meetings and set

entry and exit tones to be aware if someone has joined or left the meeting. A password for each meeting will also be required; and once all participants have joined, meetings will be locked. Lastly, the waiting room function will be utilized to help ensure that only the right people are in the meeting.

Additionally, participating in this study is on the bases of confidentiality. To ensure this, indirect identifiers will be used throughout the study to ensure that your interview cannot be linked back to you. With the exception of university name and selected major, pseudonyms will be used in place of exact references to the interviewee. Direct identifiers will be removed after the completion of data collections. Further, no efforts will be made to re-identify this data in the future. Lastly, de-identified Information obtained from this research may be used for future studies (or shared with other researchers) without obtaining your additional consent. Your confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

By participating in this interview, you consent to volunteer for this study. Please keep a copy of this form for your records.

As the researcher, I will answer any further questions about the research now or during the course of the project, and I can be reached by telephone.

_____	_____
Name of Participant (PRINT)	Signature of Participant
_____	_____
Date	Signature of Investigator Email: mark.williamsjr@uga.edu

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR.

Additional questions or problems regarding your rights as a research participant should be addressed to Chairperson of Institutional Review Board, University of Georgia; E-Mail Address IRB@uga.edu.

K-12 School Leaders

As co-principal investigator, I, Mark Anthony Williams Jr., am writing this letter to request your participation in the research study titled, ***Mechanisms Enabling School Success in STEM*** —one of three studies in the dissertation topic, *Race, Gender, and the Intersection Thereof in STEM: High Quality Education and Enablers of Success*. Under the guidance of major professor and principal investigator, Walker Swain, I will examine administrator and teacher perceptions of quality STEM programs in Metro Atlanta high schools.

This study employs an anti-deficit achievement approach—whereby the focus is on success and not failure—to survey administrators and teachers of African American students well-represented or high achieving in science, technology, engineering, and mathematics (STEM). I will use semi-structured interviews, and these interviews will provide understanding of how schools create environments of high student attainment and persistence in STEM for Black students in grades 9 through 12. Each initial interview is anticipated to last approximately 1 hour and will be recorded.

The following points will be explained to you:

1. You will be participating in an interview in which you will be asked to describe the components of quality STEM education for Black students. These factors might include, but are not limited to, the following: (1) school resources, systems, and structures that promote the success of Black students in STEM; (2) school and teacher accountability, responsibility, and expectations; (3) teacher recruitment and retention; and (4) teacher expertise and pedagogical practices.
2. No discomfort or stresses during the experiment are foreseen.
3. No risks are foreseen.
4. The results of this participation will be confidential and will not be released in any individually identifiable form without your prior consent unless required by law.
5. Your interview will be recorded.

Participation is entirely voluntary, and you can stop taking part without giving any reason and without penalty. You can refuse to participate or ask to have all of the information returned to you, removed from the research records, or destroyed. Further, a follow-up interview may be requested, which may take an additional 30 minutes. The purpose of this interview would be to further probe unanswered or underexplored questions and details from the initial interview.

Interviews will be conducted virtually by Zoom. To minimize risks associated with a potential breach of confidentiality, I will operate as the host to control who attends the meetings and set entry and exit tones to be aware if someone has joined or left the meeting. A password for each meeting will also be required; and once all participants have joined, meetings will be locked. Lastly, the waiting room function will be utilized to help ensure that only the right people are in the meeting.

Additionally, participating in this study is on the bases of confidentiality. To ensure this, indirect identifiers will be used throughout the study to ensure that your interview cannot be linked back to you. Pseudonyms will be used in place of exact references to the interviewee. Direct

identifiers will be removed after the completion of data collections, including school names. Further, no efforts will be made to re-identify this data in the future. Lastly, de-identified Information obtained from this research may be used for future studies (or shared with other researchers) without obtaining your additional consent. Your confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

By participating in this interview, you consent to volunteer for this study. Please keep a copy of this form for your records.

As the researcher, I will answer any further questions about the research now or during the course of the project, and I can be reached by telephone.

_____	_____
Name of Participant (PRINT)	Signature of Participant
_____	_____
Date	Signature of Investigator Email: mark.williamsjr@uga.edu

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR.

Additional questions or problems regarding your rights as a research participant should be addressed to Chairperson of Institutional Review Board, University of Georgia; E-Mail Address IRB@uga.edu.

APPENDIX B

INTERVIEW GUIDE

Georgia Tech Students and Alumni

Early Education and Influential Persons

1. Tell me about your earliest exposure to STEM.
2. When did you first develop an elevated interested in STEM?
3. Which family member(s), if any, were a major influence on your early persistence and success in STEM? What were the components of your support system?
4. In elementary, middle, or high school, was there a particular school leader (mentor, teacher, guidance counselor, etc.) who proved pivotal in the development of your interest and participation in STEM?
5. Was STEM educational tracking available to you at any time before reaching high school? If so, were you placed on a STEM track?

Pedagogy

6. Were you exposed to any form of cultural education practice?
7. If so, how did gender and race identity references within these practices elevate your interest, participation, and achievement in STEM?
8. How often did you experience science modeling and inquiry-oriented project-based learning?
9. How did these practices elevate your interest, participation, and achievement in STEM?

School Organization

10. What was the culture of your high school as it relates to STEM participation and success?

11. How did school culture and expectations influence your interest and high academic achievement in STEM?
12. How did teacher expectations encourage and promote your success in STEM?
13. What advanced STEM courses were offered at your high school? Which of these courses did you complete?

Testing

14. Was standardized testing required early on in your schooling? If so, how often?
15. If standardized testing was required, how were you able to maintain your interest in STEM despite your inundation in standardized testing in non-STEM subjects and lower level mathematics and science courses?

Participation in College Readiness Programs

16. What college readiness programs, if any, did you participate in prior to enrolling at Georgia Tech?
17. Were any programs that you participated in specific to Georgia Tech and/or on the campus of Georgia Tech?

K-12 School Leaders

Accountability and Expectations

1. What does educational accountability personally mean to you? (What do you feel responsible for in general?)
2. How does internal accountability work in your school? (What were are expectations for your colleagues and principal?)
3. What are you held accountable for externally? (Do you believe families of students hold you directly accountable?)

4. How do personal and school accountability play a role into the STEM engagement and development of Black students?

School and Community Mechanisms

5. How involved are the elementary and middle schools within your cluster in facilitating STEM success of Black students at your high school?
6. Is there a relatively higher allocation of financial resources to STEM programming in general in your school?
7. Are there any specific in-school resources—such field trips or special programming—that facilitate in engaging Black students in STEM?
8. Are there any out-of-school resources—in the form of external partners, philanthropic contributions, and community programming—that facilitate in engaging Black students in STEM?
9. In your classroom or school, are STEM outcomes clearly broken out by race and gender?

Recruitment and Retention

10. What mechanisms, if any, are in place to recruit and retain highly qualified teachers of STEM at your school?

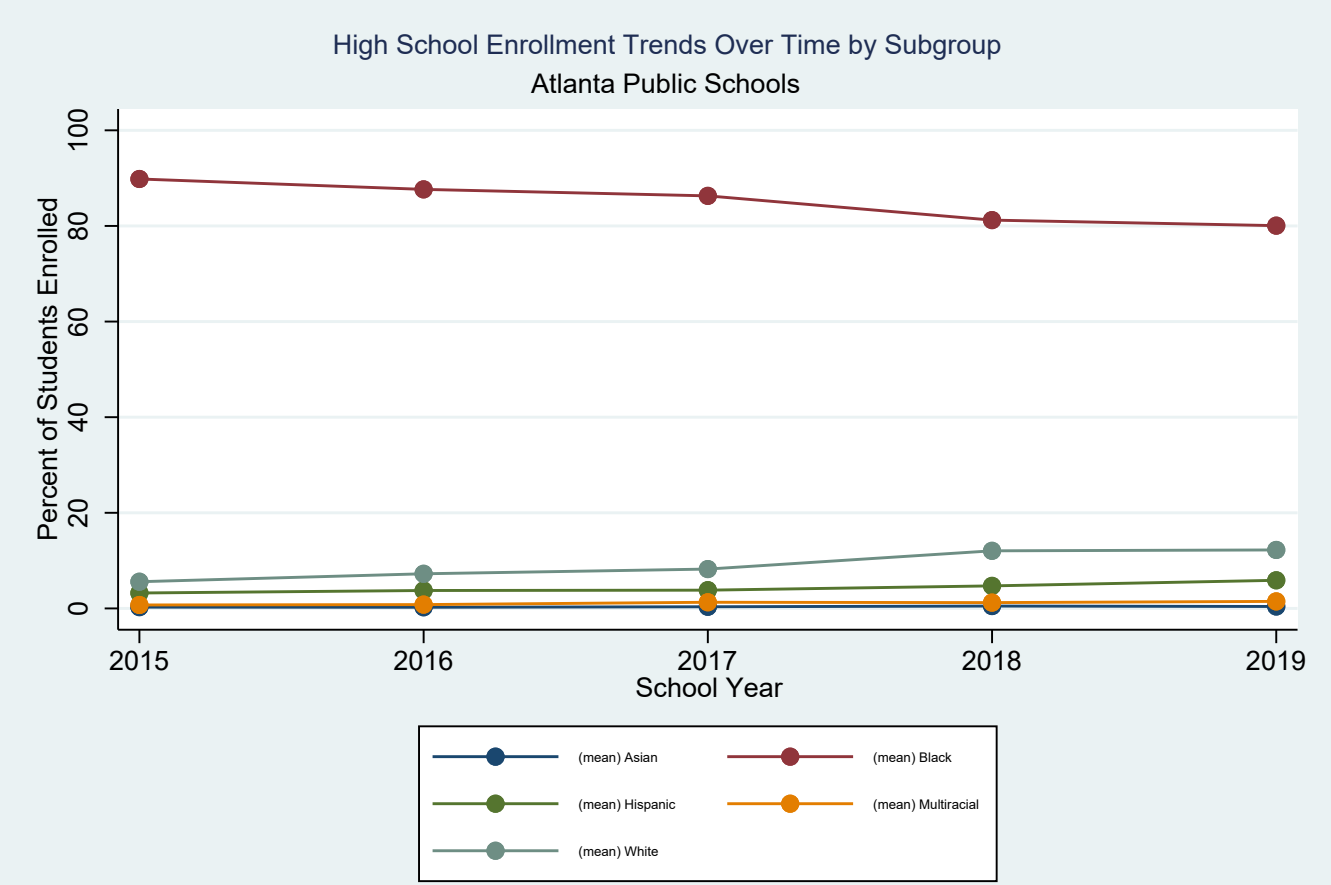
Expertise and Pedagogical Practices

11. Are specific cultural education practices emphasized in your school with the goal of reaching traditionally marginalized student groups?
12. Are there any future plans to directly or indirectly enhance the engagement of Black students in STEM at your school?

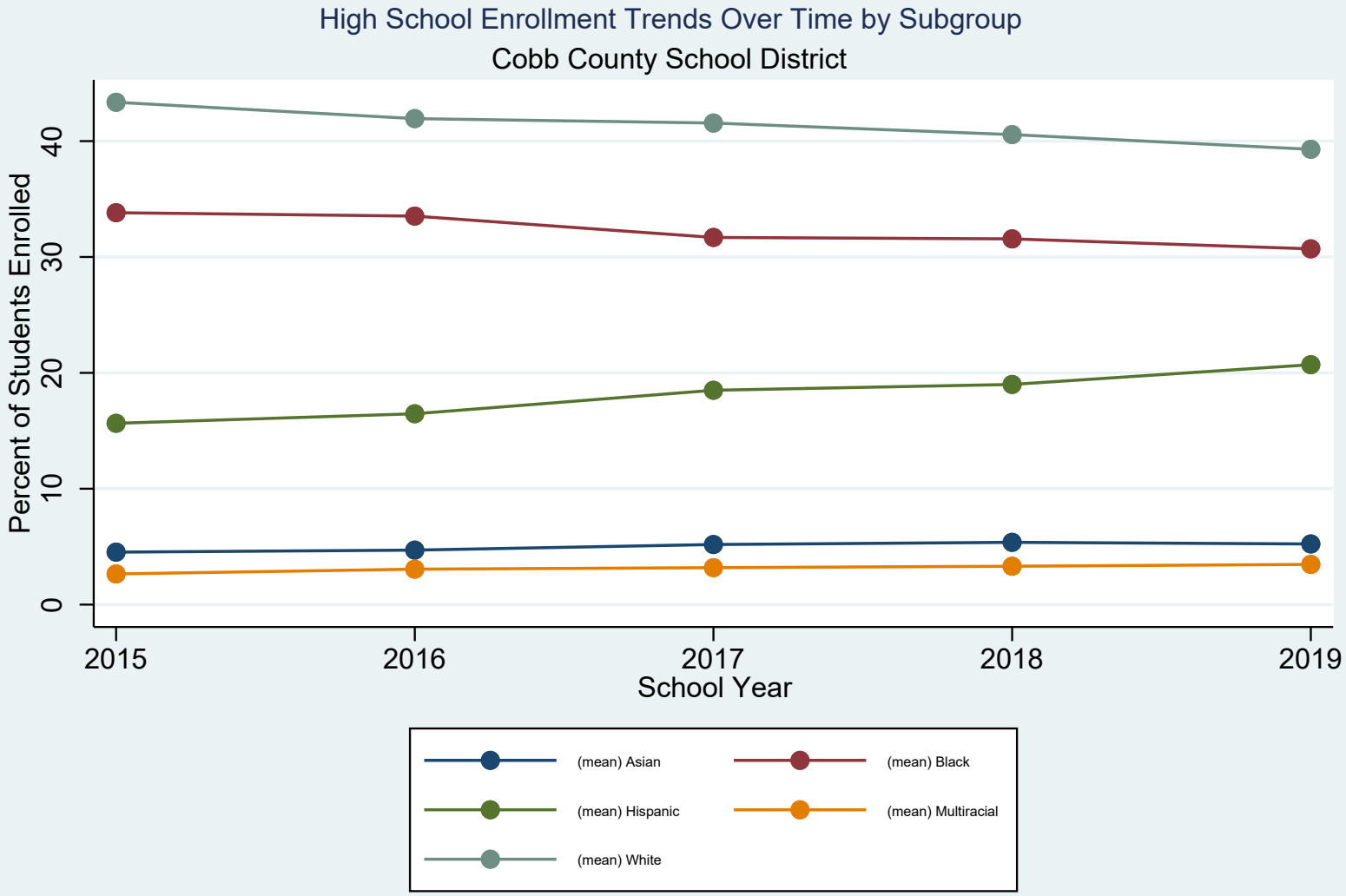
APPENDIX C

ENROLLMENT TRENDS

Atlanta Public Schools (2015-2019)

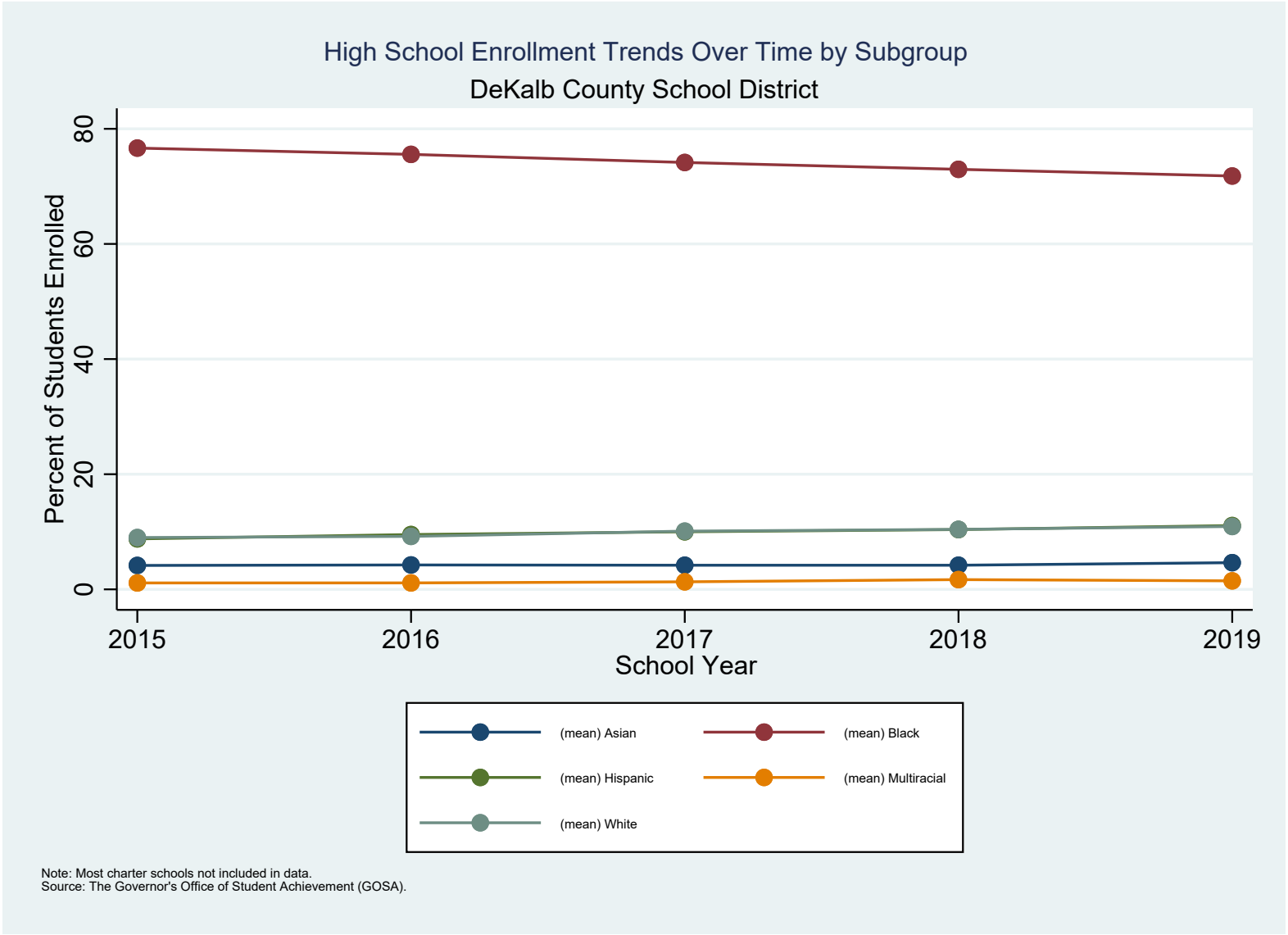


Cobb County School District (2015-2019)



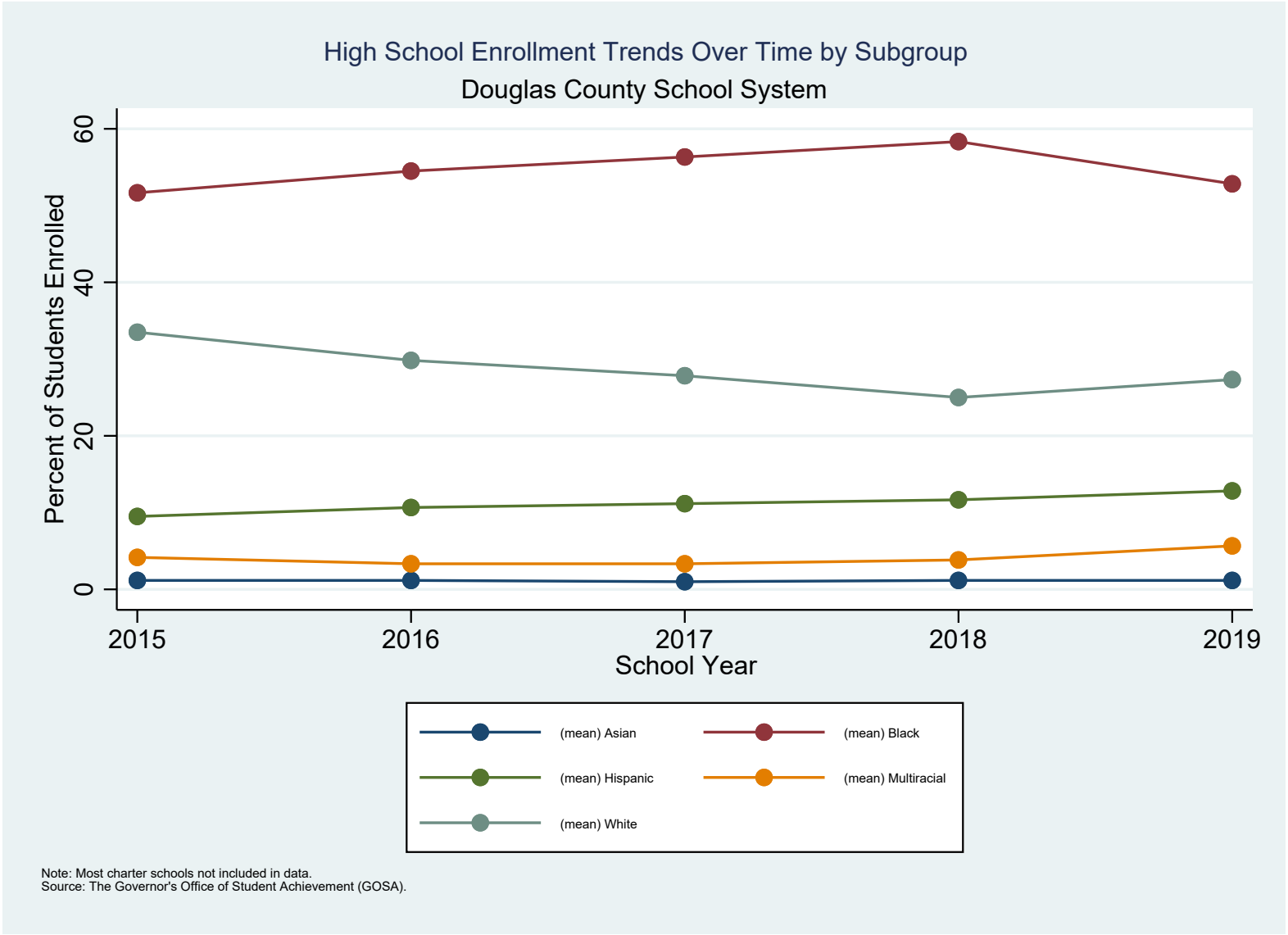
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

DeKalb County School District (2015-2019)



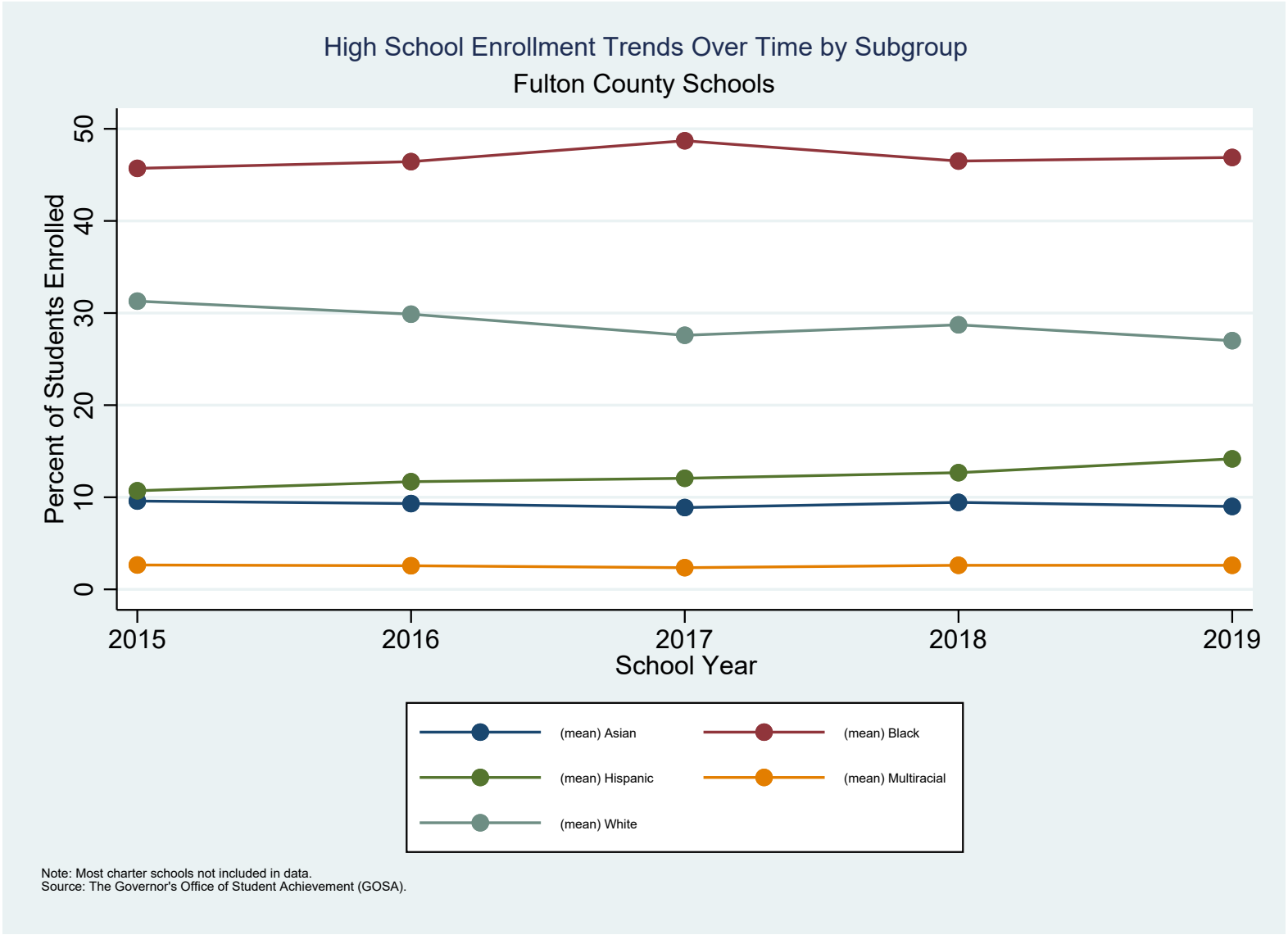
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

Douglas County School System (2015-2019)



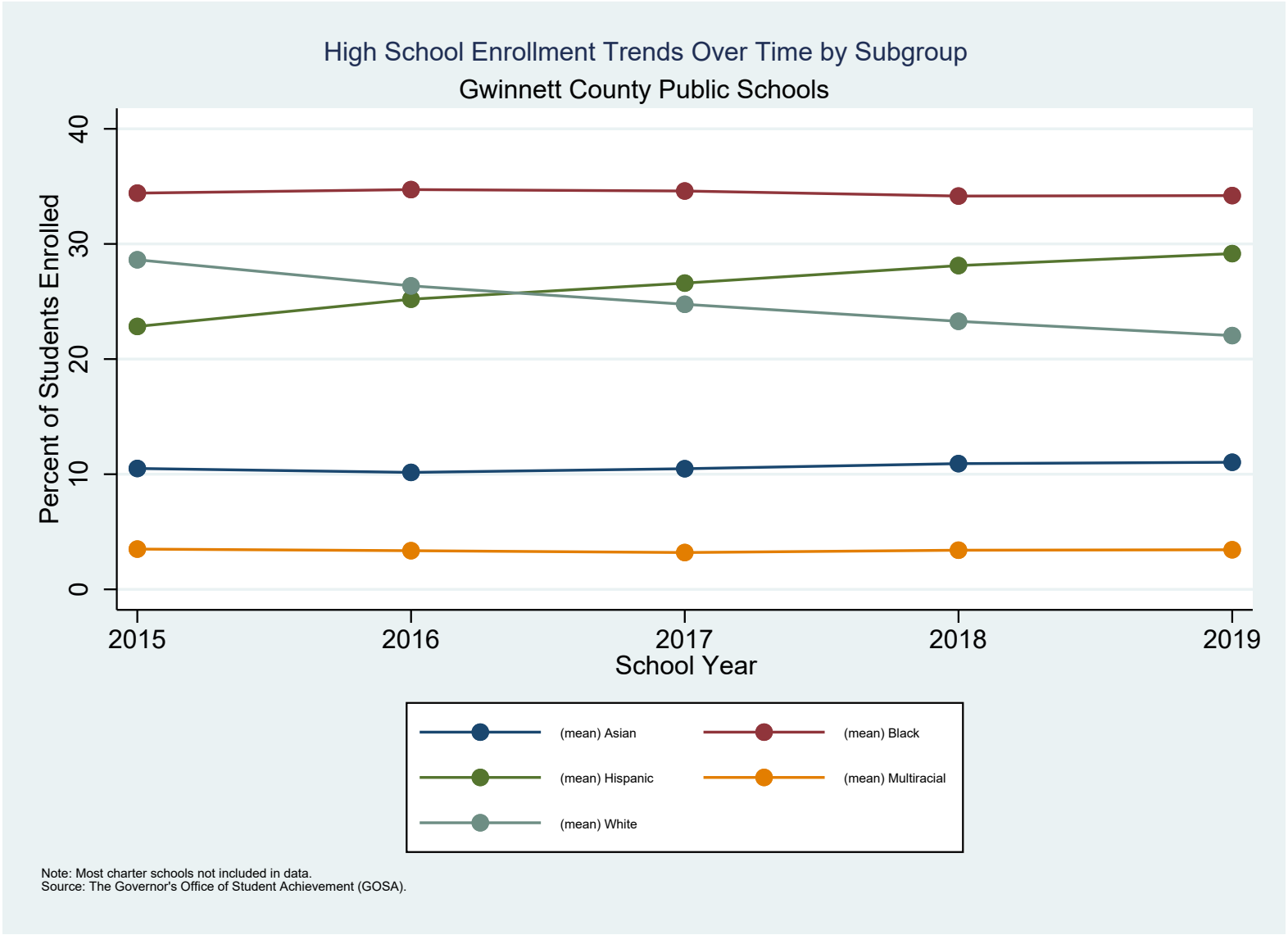
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

Fulton County Schools (2015-2019)



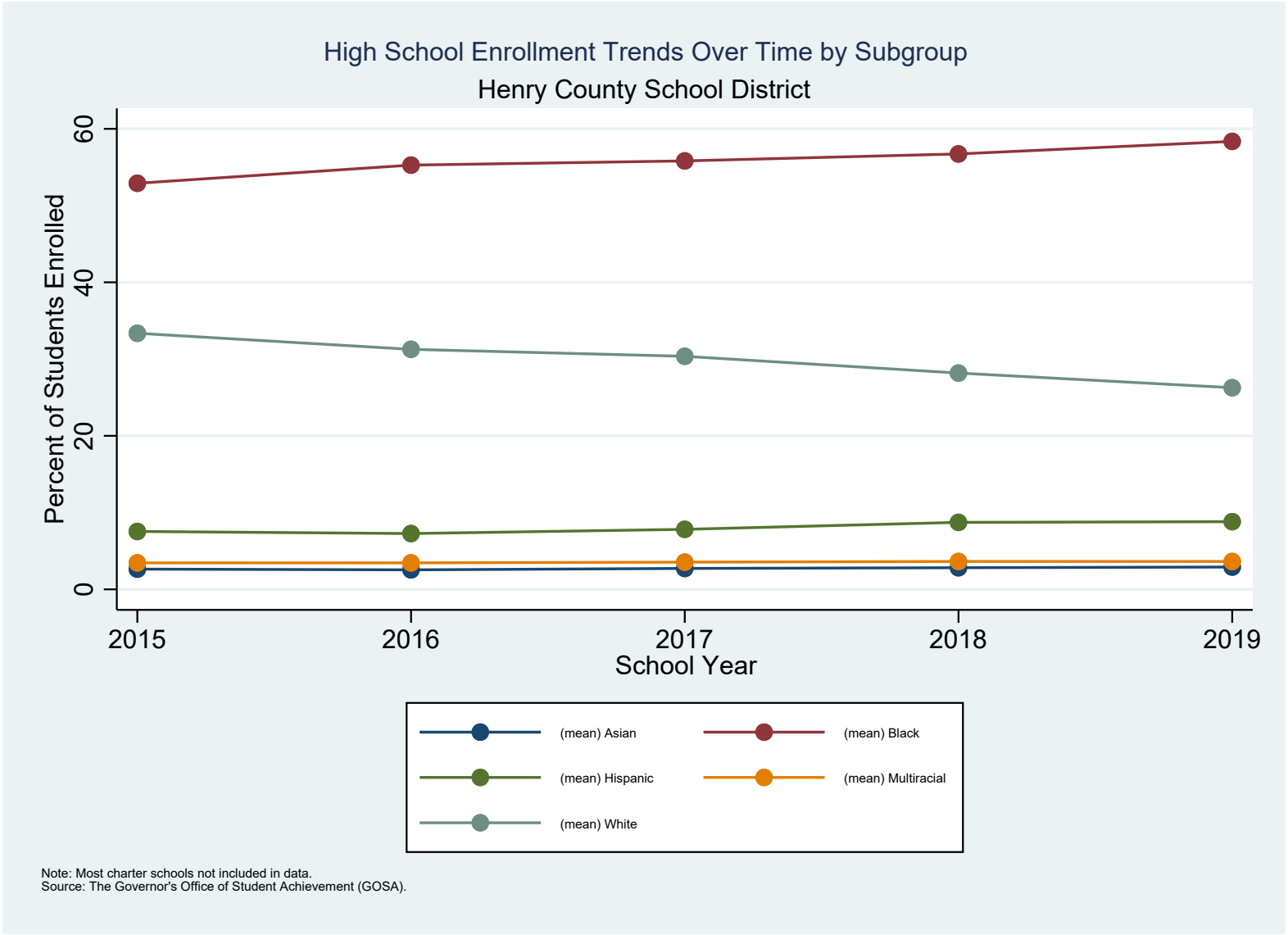
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

Gwinnett County Public Schools (2015-2019)



Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

Henry County School District (2015-2019)

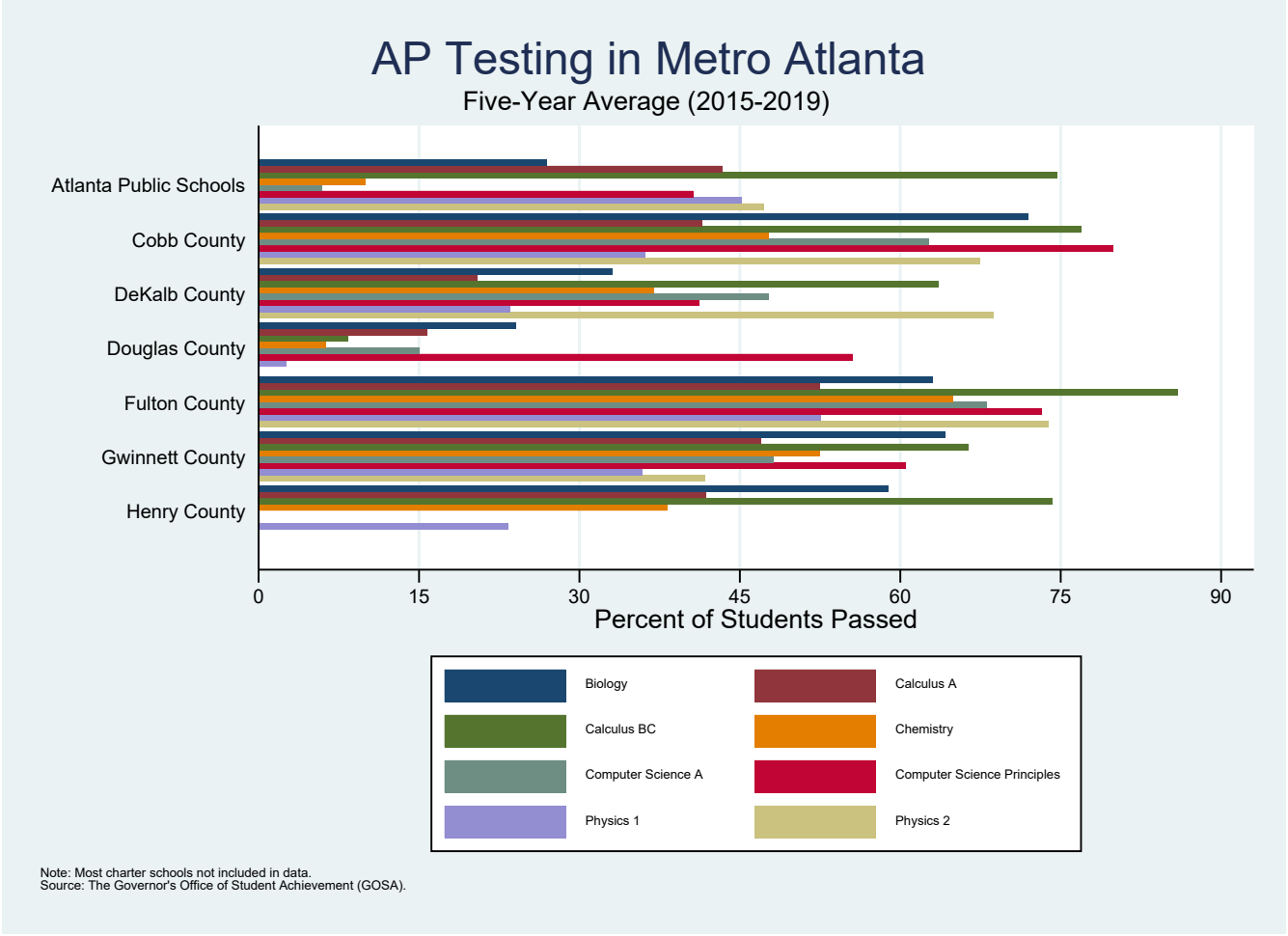


Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

APPENDIX D

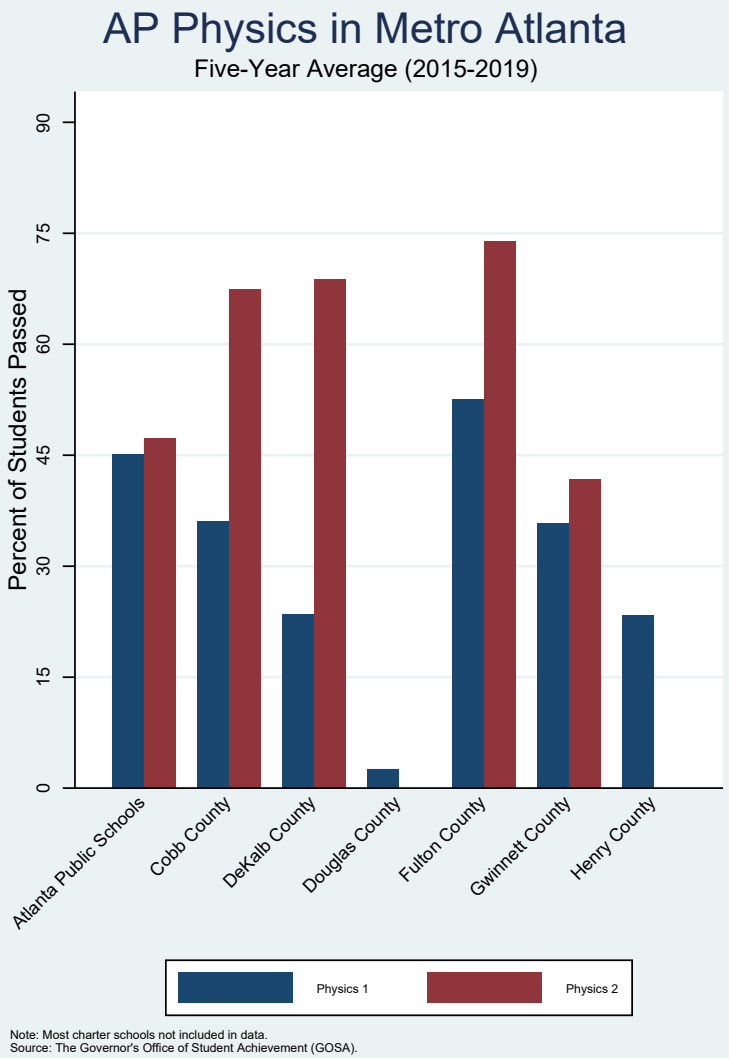
ADVANCED PLACEMENT TESTING

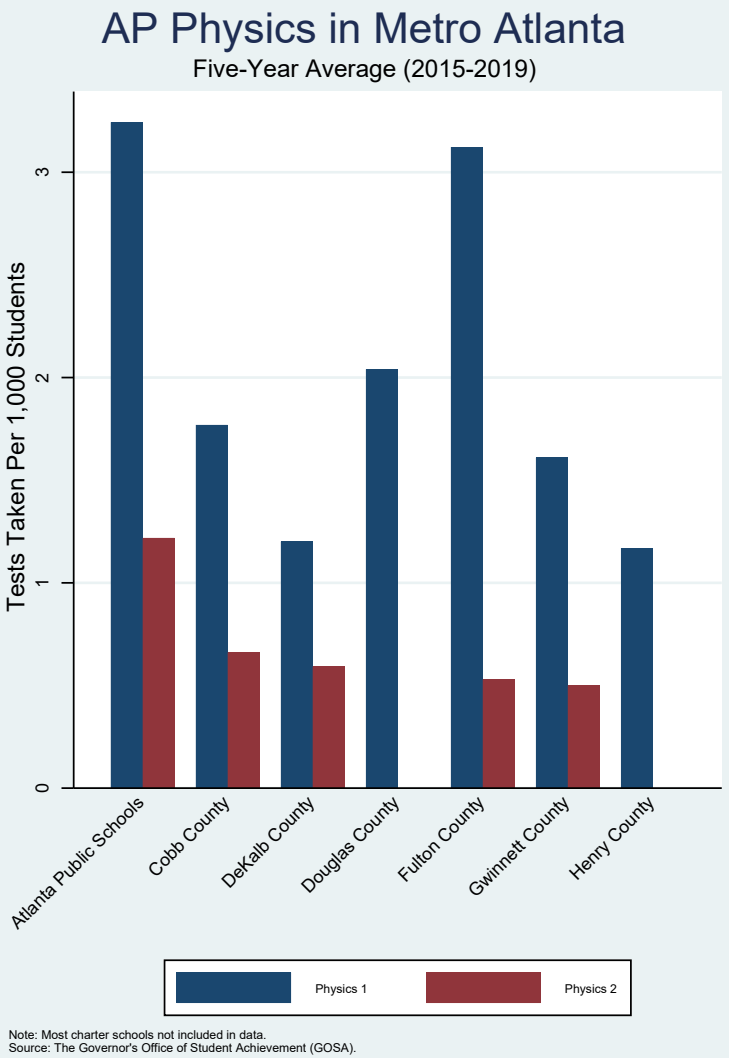
AP Testing in Metro Atlanta School Districts (2015-2019)



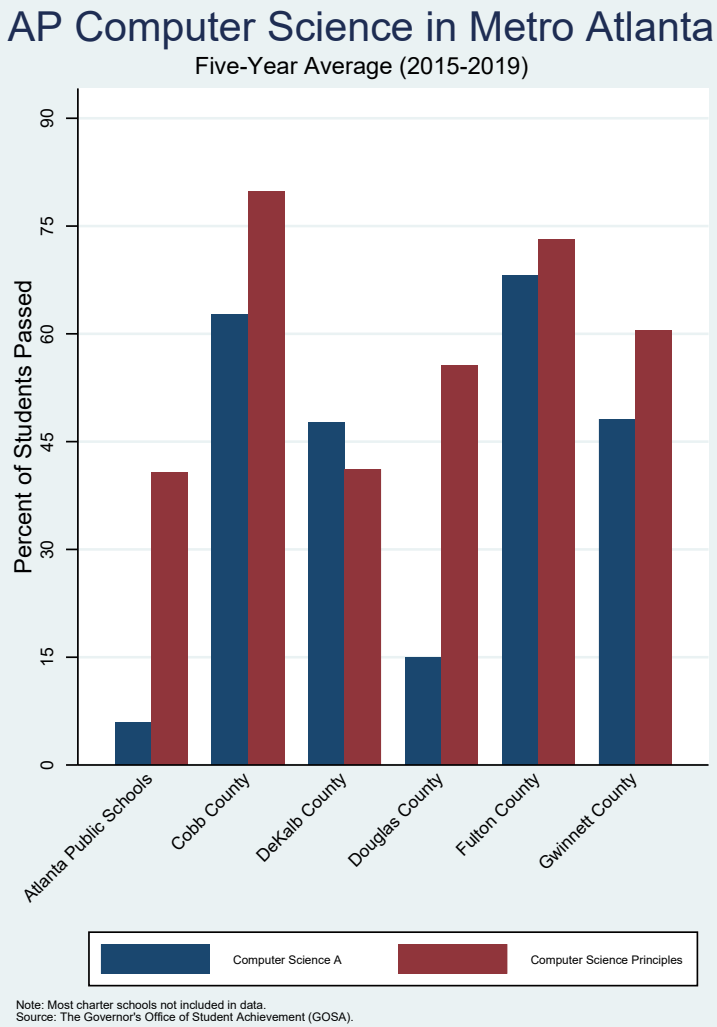
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

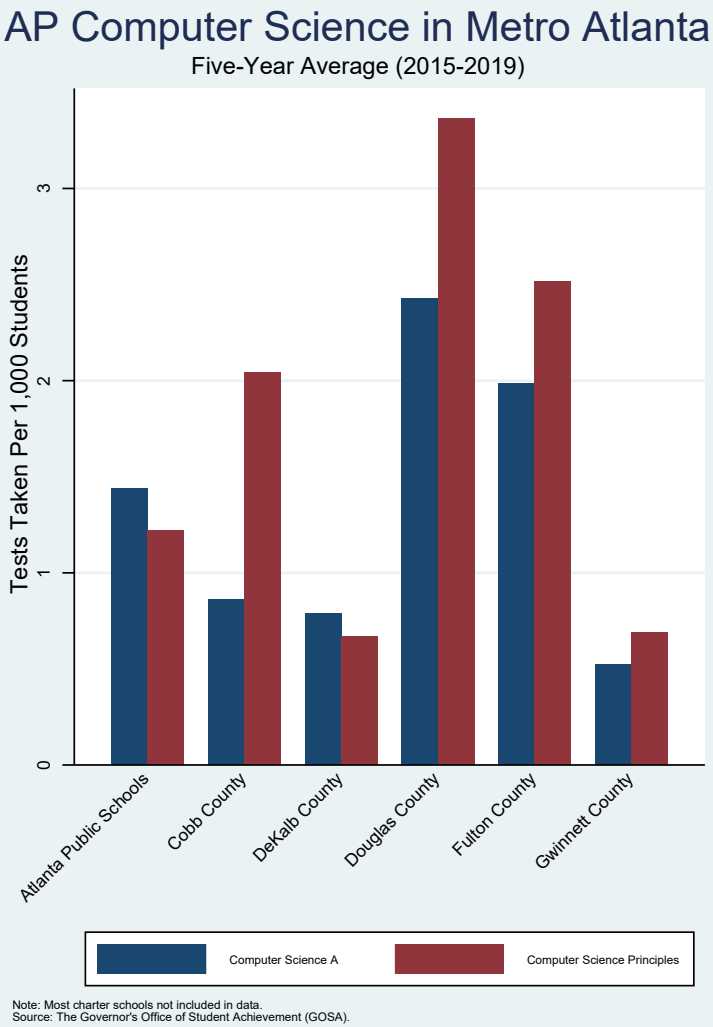
AP Physics in Metro Atlanta (2015-2019)



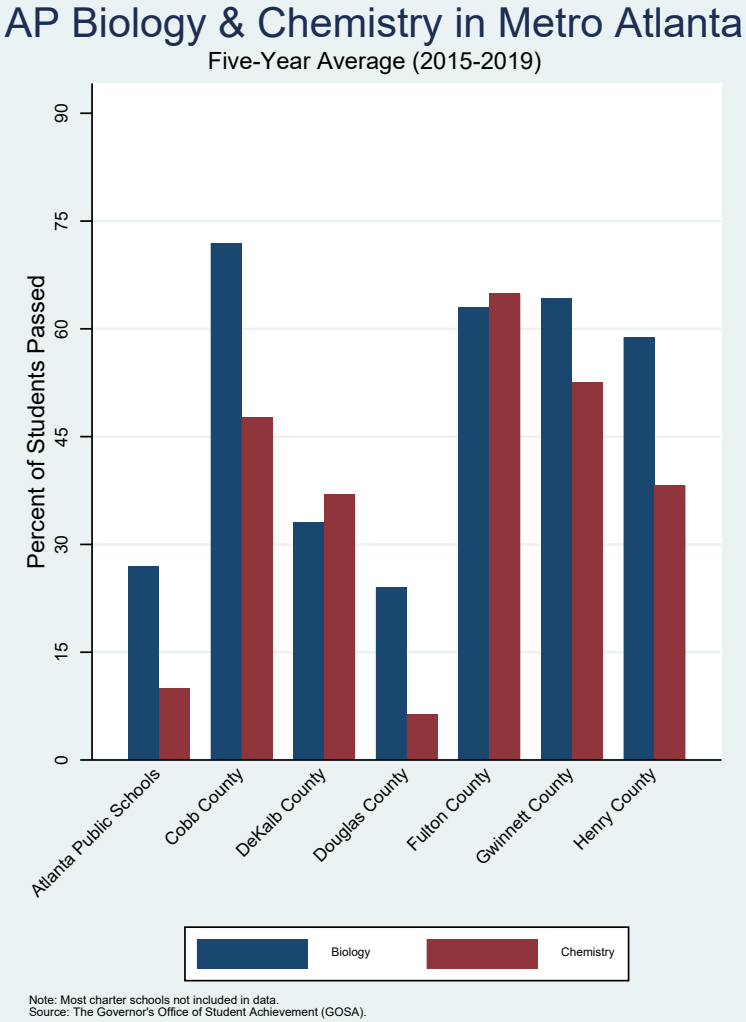


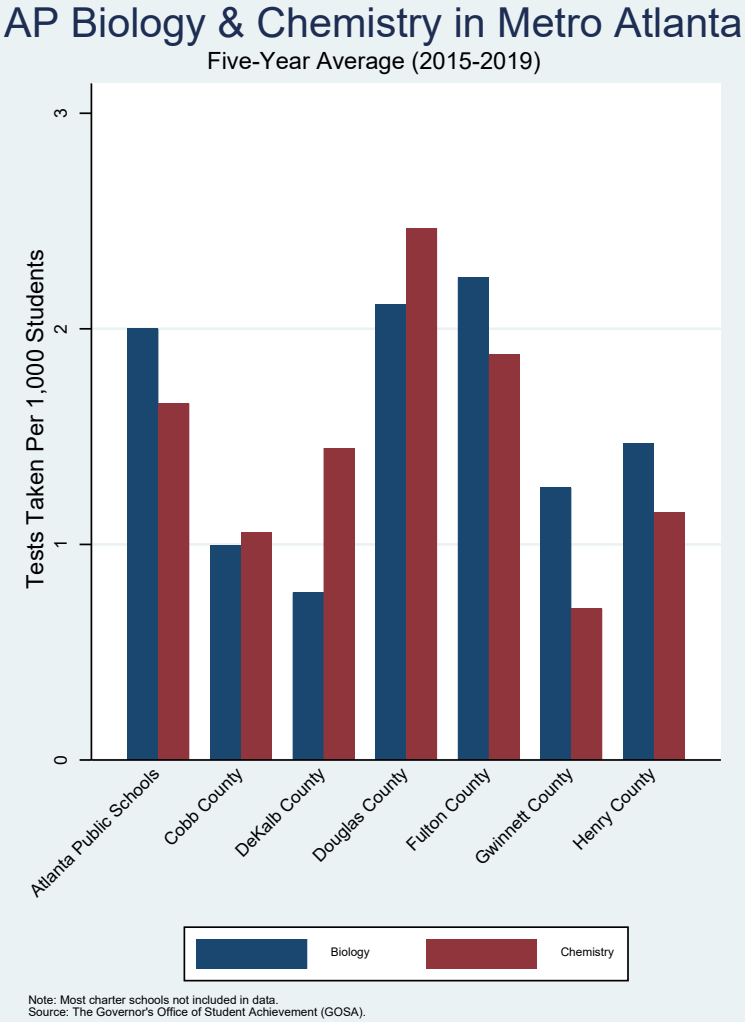
AP Computer Science in Metro Atlanta (2015-2019)





AP Biology & Chemistry in Metro Atlanta (2015-2019)

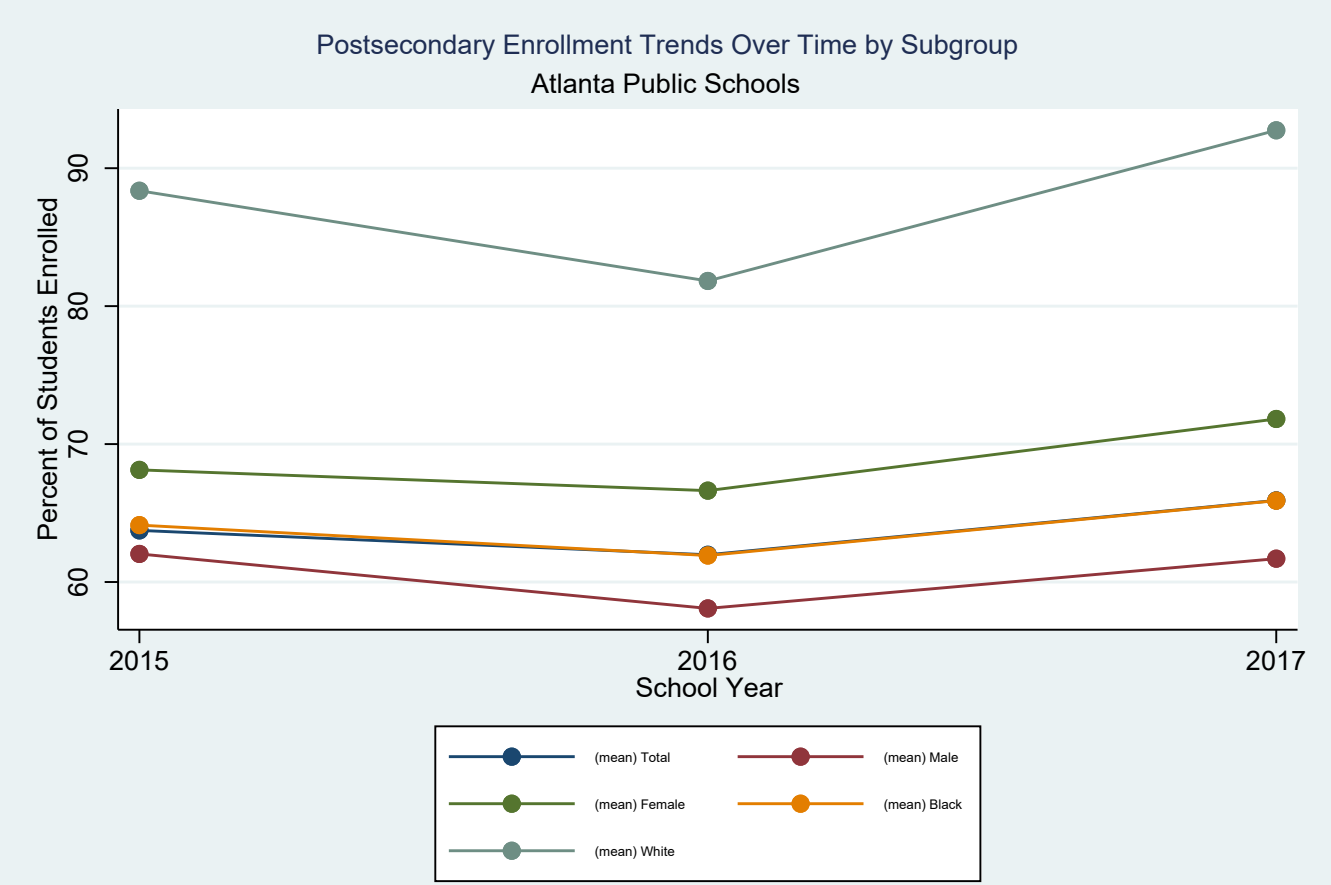




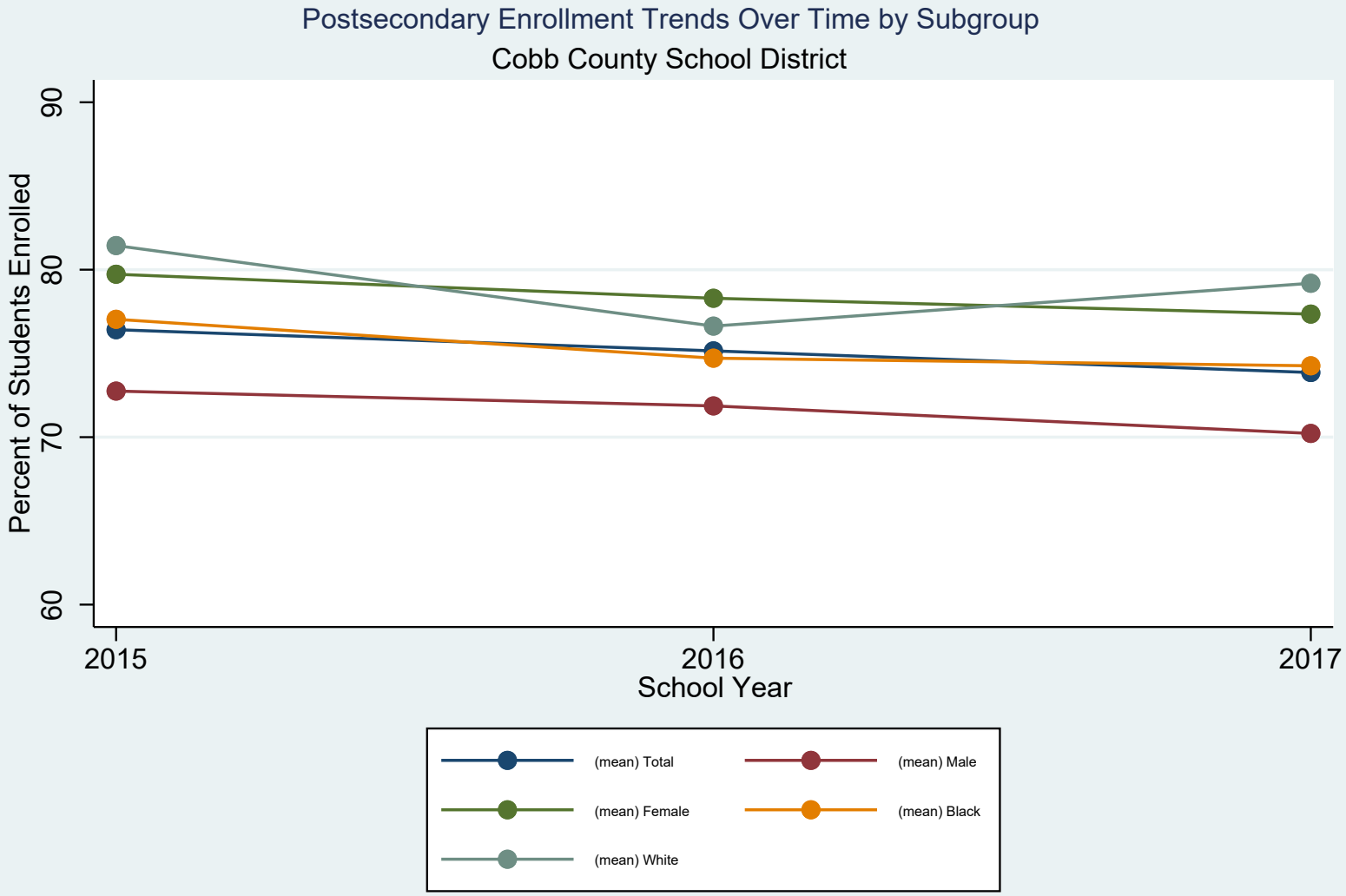
APPENDIX E

POSTSECONDARY ENROLLMENT TRENDS

Atlanta Public Schools (2015-2017)

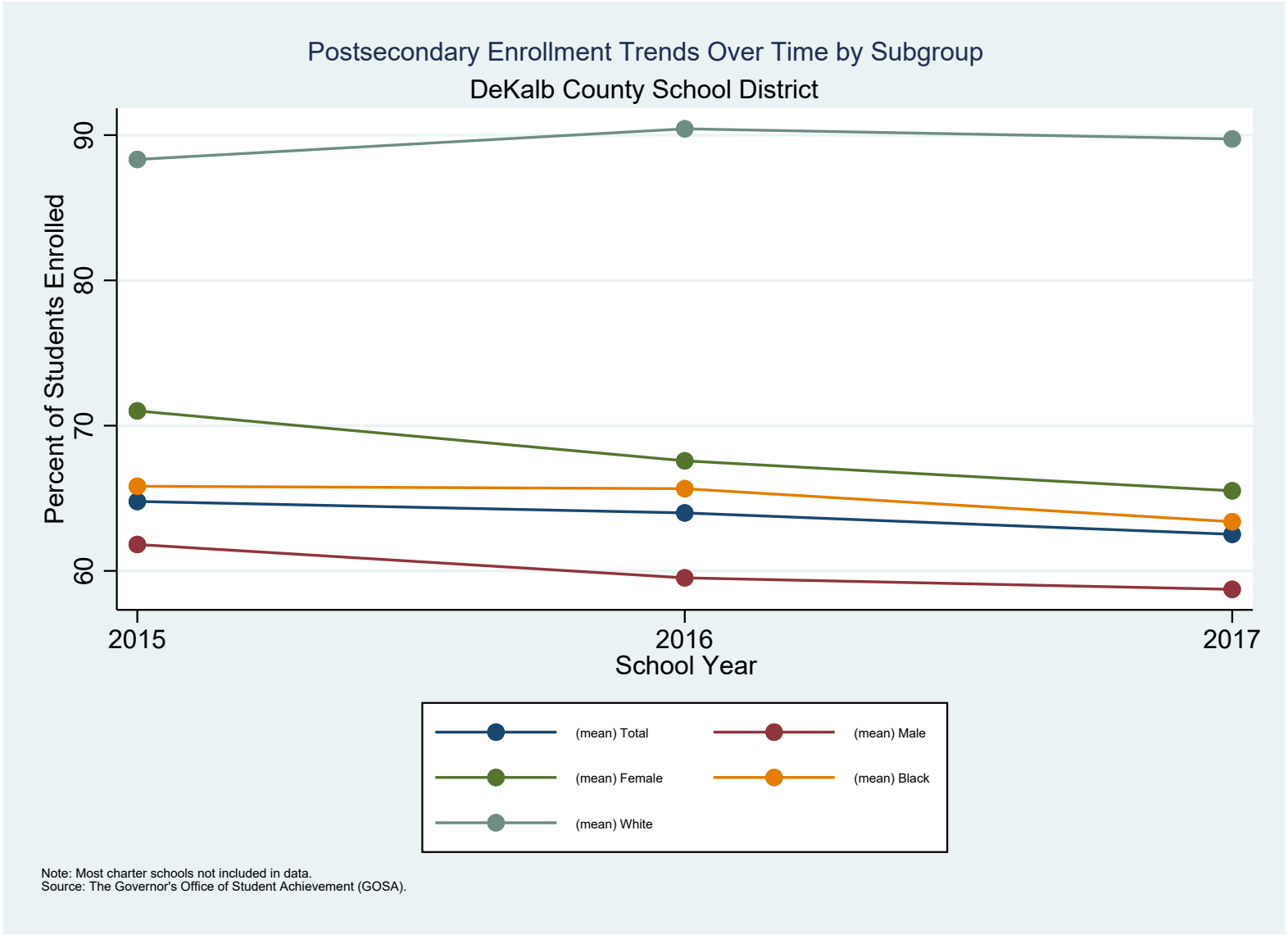


Cobb County School District (2015-2017)



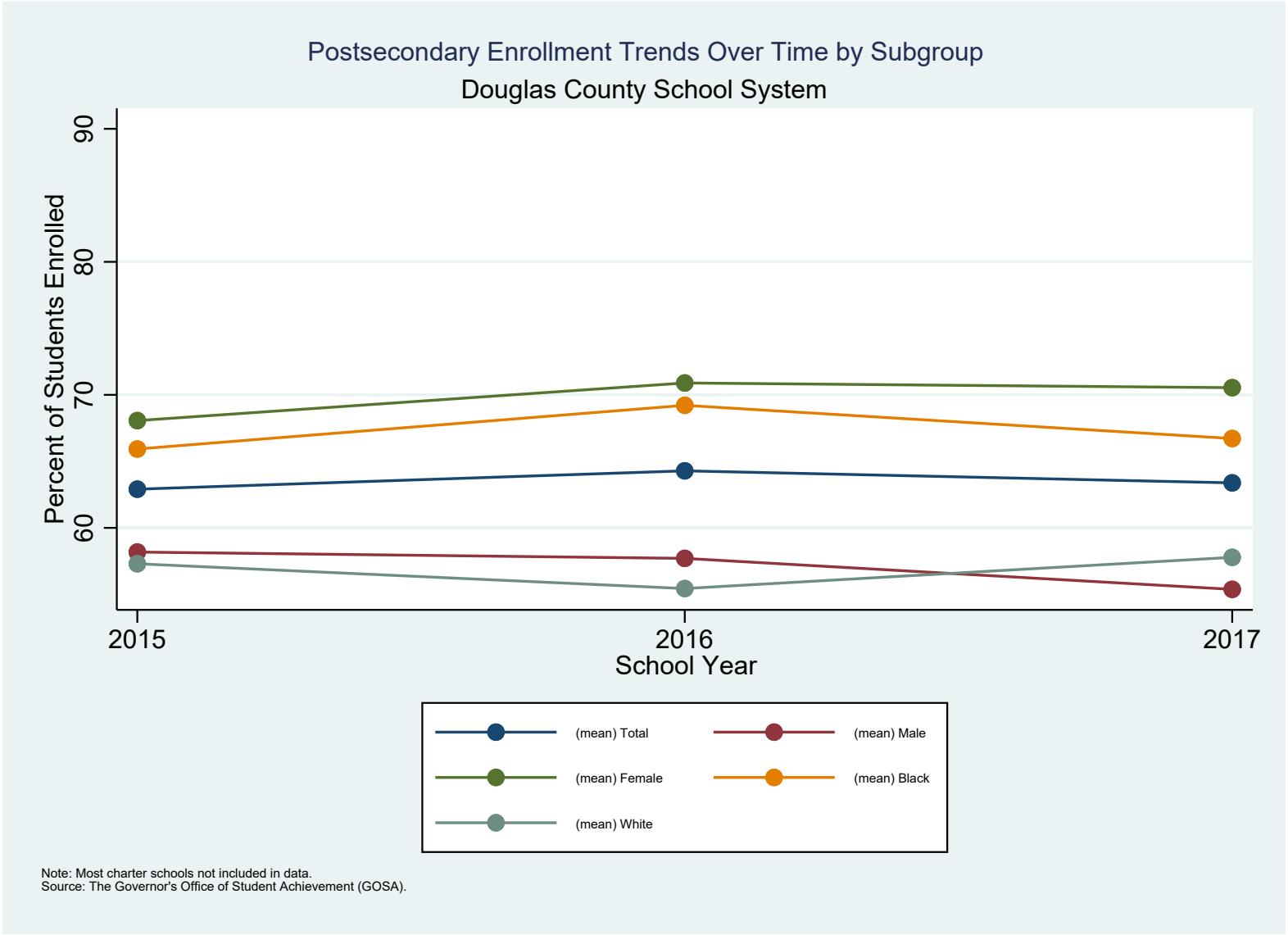
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

DeKalb County School District (2015-2017)



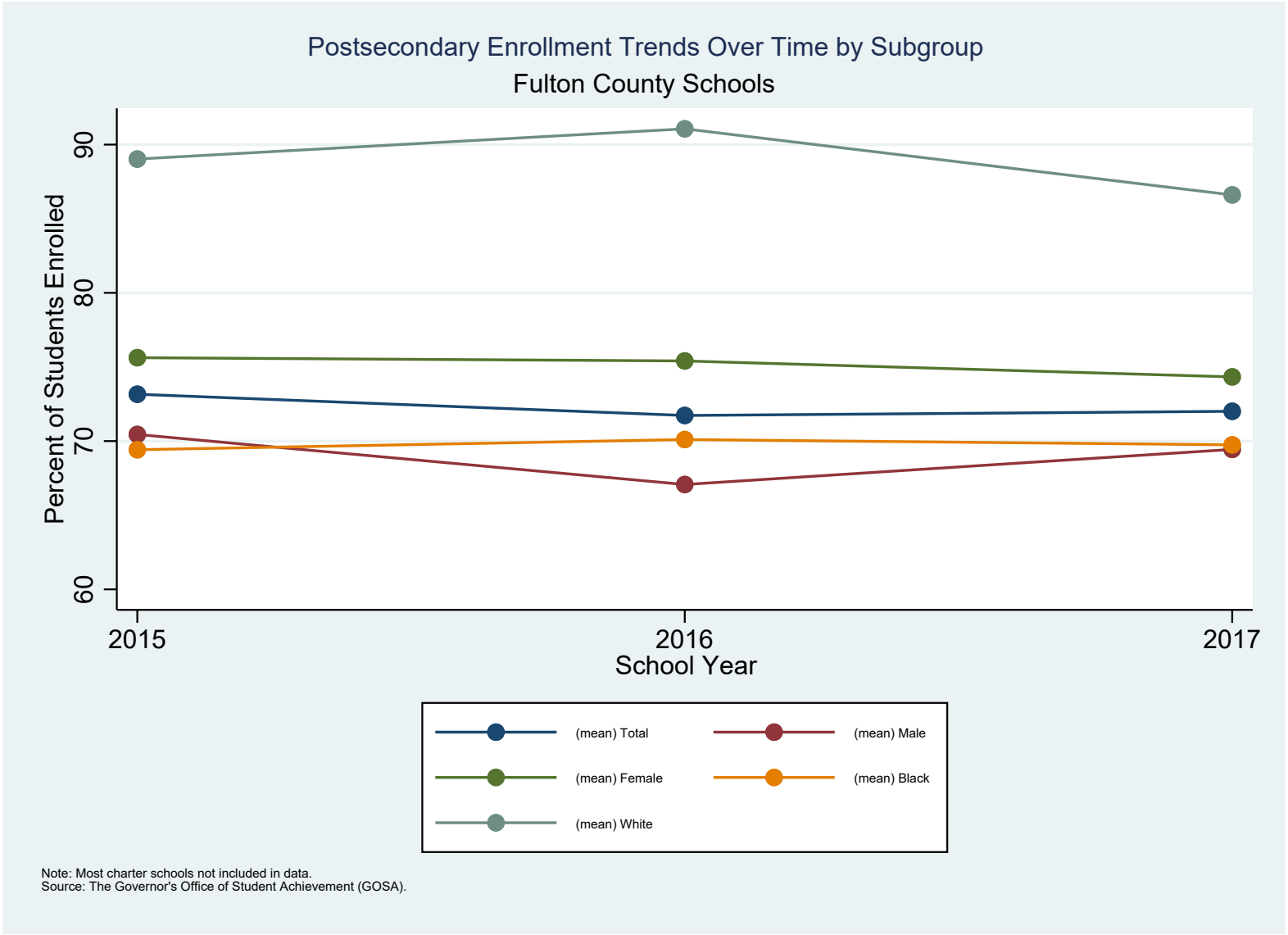
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

Douglas County School System (2015-2017)



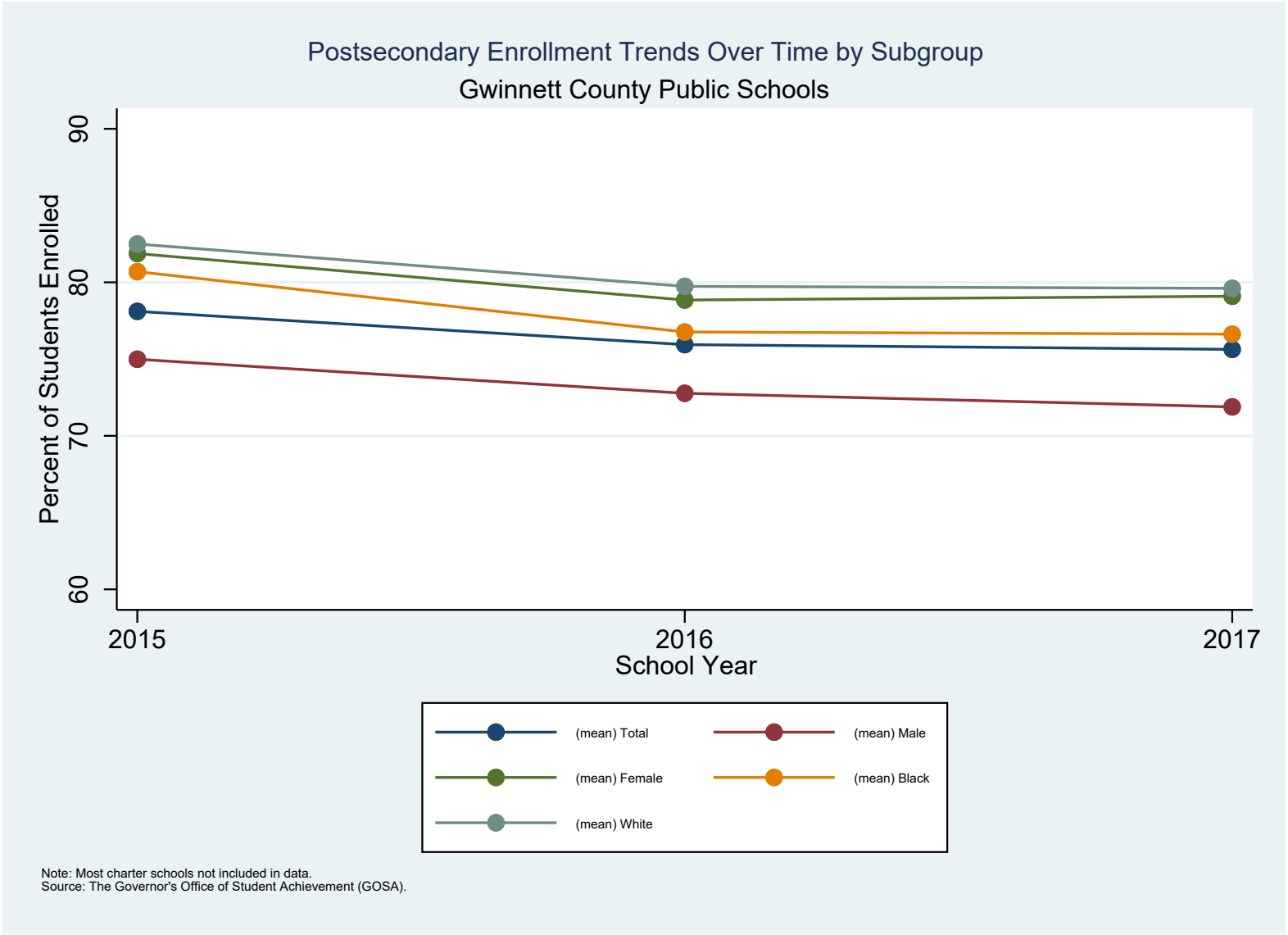
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

Fulton County Schools (2015-2017)



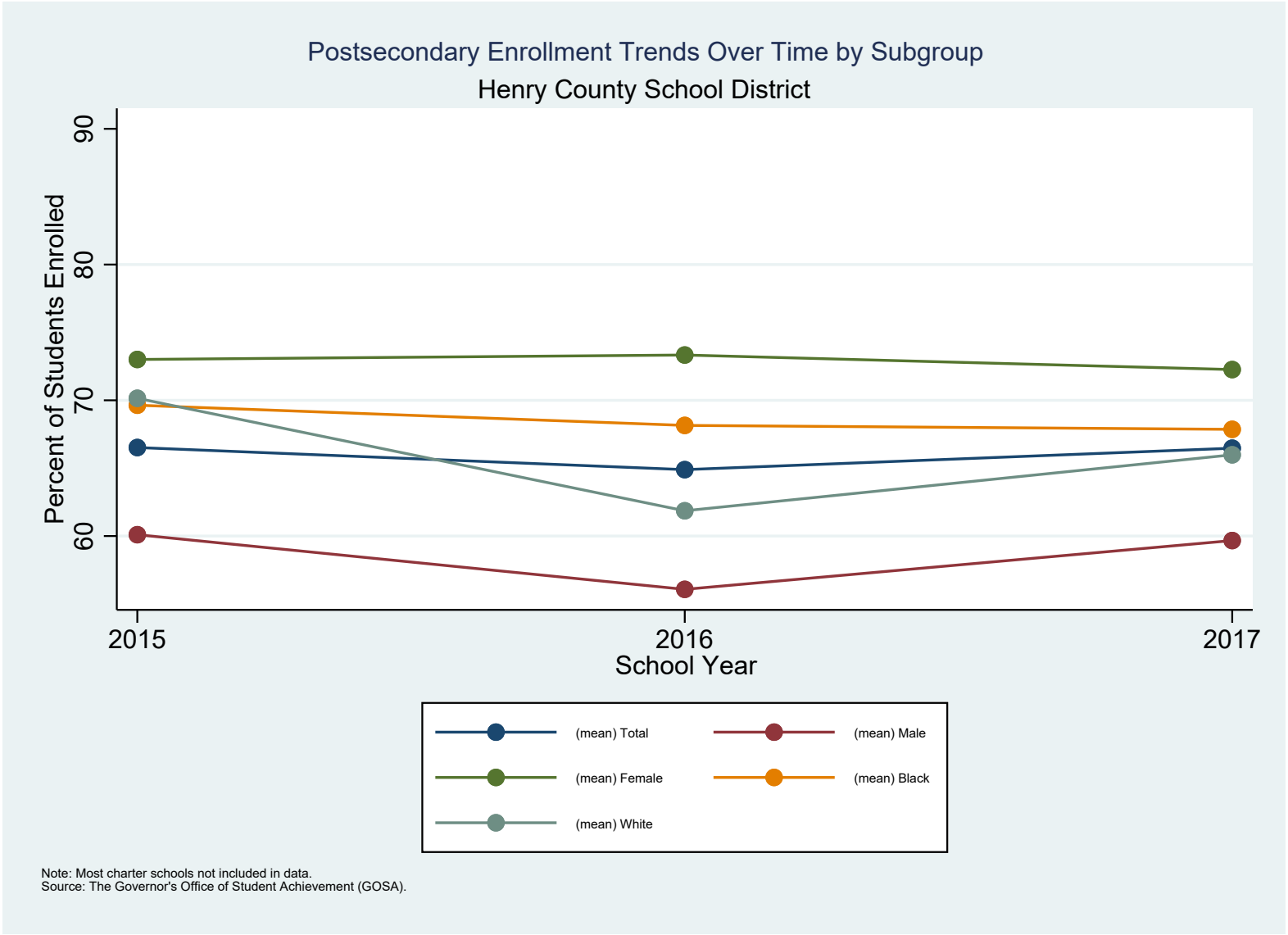
Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

Gwinnett County Public Schools (2015-2017)



Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

Henry County School District (2015-2017)



Note: Most charter schools not included in data.
Source: The Governor's Office of Student Achievement (GOSA).

APPENDIX F

END-OF-COURSE SCORES: ACHIEVEMENT GAPS

Atlanta Public Schools (2015-2019)

End of Course Scores in Math & Science by Subgroup in Atlanta Public Schools

Five Year Average (2015-2019)

School	Percent_Tested_Black	Percent_Tested_White	Percent_Distinguished_Black	Percent_Distinguished_White	Achievement_Gap
APS-Forrest Hills Academy	90.8%		0.0%		
Atlanta Classical Academy	4.3%	59.7%	0.0%	0.0%	0.0%
B.E.S.T Academy	98.4%		0.0%		
Booker T. Washington High School	97.7%		0.2%		
Carver High School	97.4%		0.0%		
Centennial Academy	76.9%		0.0%		
Corretta Scott King Womens' Leadership Academy	96.8%		0.0%		
Crim High School	96.0%		0.0%		
Douglass High School	95.6%		0.1%		
Early College High School at Carver	95.6%		4.1%		
Grady High School	51.4%	32.7%	1.2%	35.6%	-34.4%
KIPP Atlanta Collegiate	97.8%		1.8%		
Maynard H. Jackson, Jr. High School	81.3%	9.3%	1.5%	24.6%	-23.0%
Mays High School	95.8%		0.2%		
North Atlanta High School	38.1%	27.6%	2.9%	30.0%	-27.1%
Old Coretta Scott King Young Women's Academy High School	99.1%		0.0%		
School of Health Sciences and Research at Carver	98.7%		0.0%		
School of Technology at Carver	98.8%		0.0%		
South Atlanta High School	90.9%		0.0%		
South Atlanta Law and Social Justice School	94.8%		0.0%		
South Atlanta School of Computer Animation and Design	93.4%		0.0%		
South Atlanta School of Health and Medical Science	94.7%		0.0%		
The Best Academy High School at Benjamin S. Carson	98.6%		0.0%		
The School of the Arts at Carver	98.8%		0.0%		
Therrell High School	97.4%		0.0%		
Therrell School of Engineering, Math, and Science - C	97.3%		0.0%		
Therrell School of Health and Science - C	98.9%		0.0%		
Therrell School of Law, Government and Public Policy - C	98.2%		0.0%		

Cobb County School District (2015-2019)

End of Course Scores in Math & Science by Subgroup in Cobb County School Districts

Five Year Average (2015-2019)

School	Percent_Tested_Black	Percent_Tested_White	Percent_Distinguished_Black	Percent_Distinguished_White	Achievement_Gap
Allatoona High School	18.7%	64.0%	2.9%	16.7%	-13.7%
Campbell High School	42.4%	15.1%	2.3%	26.0%	-23.7%
Devereux Ackerman Academy	52.9%	12.1%	0.0%	0.0%	0.0%
Harrison High School	12.1%	75.0%	5.5%	29.2%	-23.7%
Hillgrove High School	34.8%	46.8%	10.1%	25.9%	-15.8%
Kell High School	22.2%	51.7%	0.7%	20.7%	-20.0%
Kennesaw Mountain High School	28.6%	41.9%	8.2%	28.7%	-20.5%
Lassiter High School	8.2%	71.8%	6.4%	37.6%	-31.2%
McEachern High School	68.6%	8.5%	2.0%	1.9%	0.1%
North Cobb High School	36.5%	35.1%	4.0%	13.0%	-9.0%
Osborne High School	30.0%	2.9%	0.2%	0.0%	0.2%
Pebblebrook High School	59.7%	5.5%	0.2%	3.3%	-3.2%
Pope High School	5.7%	77.4%	1.6%	30.4%	-28.8%
South Cobb High School	62.4%	7.1%	2.5%	0.9%	1.6%
Sprayberry High School	28.0%	36.9%	0.6%	12.6%	-12.1%
Walton High School	5.9%	68.9%	2.3%	41.9%	-39.6%
Wheeler High School	43.4%	22.6%	5.8%	42.5%	-36.7%

DeKalb County School District (2015-2019)

End of Course Scores in Math & Science by Subgroup in DeKalb County School District

Five Year Average (2015-2019)

School	Percent_Tested_Black	Percent_Tested_White	Percent_Distinguished_Black	Percent_Distinguished_White	Achievement_Gap
Arabia Mountain High School - Academy of Engineering, Medicine and Environm	97.0%		4.5%		
Cedar Grove High School	96.1%		1.0%		
Clarkston High School	60.8%	1.0%	0.2%	0.0%	0.2%
Columbia High School	97.3%		0.1%		
Cross Keys High School	3.5%		0.0%		
DeKalb Alternative School	82.8%		0.0%		
DeKalb School of the Arts	58.4%	26.1%	2.5%	16.0%	-13.5%
Dekalb Early College Academy	88.7%		23.4%		
Destiny Achievers Academy of Excellence	96.4%		0.0%		
Druid Hills High School	45.5%	18.8%	0.3%	20.7%	-20.3%
Dunwoody High School	15.8%	43.1%	0.2%	30.8%	-30.5%
Elizabeth Andrews High School	68.9%		0.0%		
Lakeside High School	24.0%	27.4%	1.1%	24.1%	-22.9%
Lithonia High School	92.1%		0.2%		
Martin Luther King, Jr. High School	96.8%		0.4%		
McNair High School	94.1%		0.1%		
Miller Grove High School	95.7%		0.3%		
Redan High School	93.3%		0.1%		
Southwest DeKalb High School	96.4%		0.6%		
Stephenson High School	94.4%		0.4%		
Stone Mountain High School	79.7%	0.3%	0.1%	0.0%	0.1%
Towers High School	91.4%		0.1%		
Tucker High School	62.3%	6.6%	1.1%	15.6%	-14.4%

Douglas County School System (2015-2019)

End of Course Scores in Math & Science by Subgroup in Douglas County School System

Five Year Average (2015-2019)

School	Percent_Tested_Black	Percent_Tested_White	Percent_Distinguished_Black	Percent_Distinguished_White	Achievement_Gap
Alexander High School	26.0%	56.0%	0.0%	6.6%	-6.6%
Chapel Hill High School	55.4%	25.1%	1.9%	4.8%	-2.9%
Douglas County High School	65.9%	13.6%	4.4%	21.6%	-17.3%
Lithia Springs Comprehensive High School	51.5%	14.0%	0.9%	0.7%	0.2%
New Manchester High School	77.6%	6.8%	1.2%	0.2%	1.0%
Youth Villages at Inner Harbour	34.5%		0.0%		

Fulton County Schools (2015-2019)

End of Course Scores in Math & Science by Subgroup in Fulton County Schools

Five Year Average (2015-2019)

School	Percent_Tested_Black	Percent_Tested_White	Percent_Distinguished_Black	Percent_Distinguished_White	Achievement_Gap
Alpharetta High School	20.8%	44.2%	4.7%	32.7%	-28.0%
Amana Academy School	3.1%	20.6%	0.0%	0.0%	0.0%
Banneker High School	95.0%		0.0%		
Cambridge High School	10.5%	68.4%	2.6%	29.3%	-26.6%
Centennial High School	25.6%	36.8%	0.4%	22.4%	-22.0%
Chattahoochee High School	12.9%	47.7%	2.5%	31.9%	-29.4%
Creekside High School	88.3%	0.3%	0.0%	0.0%	0.0%
Fulton Science Academy High School	33.2%	27.5%	7.3%	16.2%	-8.9%
Independence High School	16.7%	3.9%	0.0%	0.0%	0.0%
Johns Creek High School	10.0%	54.8%	3.9%	28.1%	-24.2%
KIPP South Fulton Academy School	97.6%		7.2%		
Langston Hughes High School	89.9%		0.1%		
Latin College Prep	88.7%		0.0%		
McClarin High School	86.3%		0.0%		
Milton High School	11.1%	61.1%	4.0%	25.8%	-21.8%
North Springs High School	51.4%	23.3%	3.1%	23.2%	-20.1%
Northview High School	13.9%	31.1%	1.4%	26.2%	-24.8%
Roswell High School	14.8%	53.0%	2.0%	32.0%	-30.0%
Skyview High School	58.3%		0.0%		
Tri-Cities High School	67.7%		0.1%		
Westlake High School	96.3%		4.0%		

Gwinnett County Public Schools (2015-2019)

End of Course Scores in Math & Science by Subgroup in Gwinnett County Public Schools

Five Year Average (2015-2019)

School	Percent_Tested_Black	Percent_Tested_White	Percent_Distinguished_Black	Percent_Distinguished_White	Achievement_Gap
Archer High School	43.6%	35.0%	5.9%	16.0%	-10.1%
Berkmar High School	25.3%	2.1%	1.1%	2.0%	-1.0%
Brookwood High School	28.6%	35.3%	13.3%	29.0%	-15.7%
Central Gwinnett High School	46.8%	7.9%	1.8%	2.7%	-0.9%
Collins Hill High School	29.4%	24.4%	7.1%	27.7%	-20.6%
Dacula High School	41.3%	28.3%	8.2%	19.3%	-11.1%
Discovery High School	37.0%	5.0%	2.2%	2.3%	-0.2%
Duluth High School	30.1%	14.6%	4.3%	25.8%	-21.5%
Grayson High School	48.6%	27.3%	8.9%	18.1%	-9.2%
Gwinnett InterVention Education (GIVE) Center East	55.1%	4.7%	0.0%	0.0%	0.0%
Gwinnett Intervention Education Center (GIVE) West	34.0%		0.0%		
Gwinnett Online Campus	4.2%	58.3%	0.0%	0.0%	0.0%
Gwinnett School of Mathematics, Science and Technology	25.1%	17.7%	56.6%	70.8%	-14.1%
Lanier High School	19.5%	41.5%	1.9%	15.5%	-13.5%
Meadowcreek High School	21.1%	1.8%	0.3%	0.9%	-0.6%
Mill Creek High School	19.2%	53.4%	9.1%	24.1%	-14.9%
Mountain View High School	26.5%	36.7%	7.3%	17.9%	-10.6%
Norcross High School	30.0%	11.4%	2.5%	34.6%	-32.1%
North Gwinnett High School	12.0%	54.0%	8.3%	29.3%	-21.0%
Parkview High School	26.5%	28.1%	7.5%	21.8%	-14.2%
Paul Duke STEM High School	24.4%	12.1%	0.0%	22.2%	-22.2%
Peachtree Ridge High School	30.1%	20.3%	5.0%	23.9%	-18.9%
Phoenix High School	18.8%		0.0%		
Shiloh High School	72.4%	3.8%	2.0%	0.0%	2.0%
South Gwinnett High School	73.6%	5.8%	1.6%	0.6%	1.0%

Henry County School District (2015-2019)

End of Course Scores in Math & Science by Subgroup in Henry County School District

Five Year Average (2015-2019)

School	Percent_Tested_Black	Percent_Tested_White	Percent_Distinguished_Black	Percent_Distinguished_White	Achievement_Gap
Dutchtown High	75.7%	5.5%	1.5%	0.2%	1.3%
EXCEL Academy	63.8%		0.0%		
Eagle's Landing High School	72.6%	6.6%	0.4%	0.0%	0.4%
Hampton High School	57.2%	26.0%	0.1%	0.4%	-0.3%
Henry County High School	80.0%	5.5%	0.0%	0.0%	0.0%
Locust Grove High	21.2%	61.4%	0.2%	1.2%	-1.0%
Luella High School	64.0%	14.9%	0.6%	1.5%	-0.8%
Ola High School	21.3%	67.4%	1.7%	8.8%	-7.1%
Patrick Henry High School	66.5%	10.4%	0.0%	0.0%	0.0%
Stockbridge High School	72.1%	9.3%	0.4%	0.6%	-0.2%
Union Grove High	32.5%	51.4%	3.5%	13.6%	-10.2%
Woodland High School	57.7%	24.0%	1.4%	2.0%	-0.6%