

ARE BLACK GIRLS THE NEW NUMBER RUNNERS? AN ANALYSIS
OF BLACK GIRLS AND HIGH SCHOOL MATHEMATICS

by

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This manuscript has been read and accepted by the Graduate Faculty in Urban Education in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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AbstractARE BLACK GIRLS THE NEW NUMBER RUNNERS? AN ANALYSIS
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According to the National Science Foundation (NSF), one out of every 100 employed scientists and engineers in the United States is a Black female. This statistic prompts the examination of Black females and mathematics. How do individual-level (educational aspirations), familial-level (support), and school-level (school characteristics) variables impact Black female students' proficiency in high school mathematics as well as predict their enrollment in postsecondary math courses?

Employing four waves from the National Education Longitudinal Study (1988, 1990, 1992, & 1994), this study seeks to add to the discourse on achievement in mathematics by examining factors which impact outcomes in mathematics for a nationally representative sample of Black females.

The theoretical framework for this dissertation will include, but not be limited to, social and cultural capital (Bourdieu and Coleman), intersectionality and standpoint (Crenshaw and Collins) theory.

Variables from all three levels affected Black females' achievement in high school mathematics. The score on the twelfth grade math exam was significant in predicting the likelihood that a Black female enrolled in a regular mathematics course in a postsecondary institution.

The findings from this study will help inform the development of interventions and strategies aimed at increasing the mathematics proficiency of Black females and their enrollment in postsecondary mathematics courses.

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Chapter One: Background and Introduction

1.1 Introduction

1.1.1 Statement of the problem. If the jobs of the future, as articulated by the Obama Administration's American Graduation Initiative of 2020, increasingly demand a great deal of technical skill, how will Black¹ females fare in this labor market? The rapid advances in technology and the movement toward a global economy has put a premium on knowledge in general, and on science and mathematics in particular. Global economic changes have led to dramatic increases in the number of workers needed in science, technology, engineering, and mathematics (STEM) careers, thereby increasing the need for more high school students who complete rigorous science and mathematics coursework. What individual-level, familial-level, and school-level variables impact Black females' proficiency in mathematics?

1.1.2 Rationale. The 2011 National Assessment of Educational Progress (NAEP) reported that, of the eighth-graders who comprise the 75th percentile, only 5% were Black students compared to 72 % of their White counterparts. Despite decades of school reform and federal mandate policies, researchers in America² have confirmed persistent disparities in mathematics achievement and enrollment in advanced-level mathematics classes between White middle-class males and other groups of students, such as females, African Americans, those from culturally diverse backgrounds, and students from low socioeconomic status (SES) (Kerr & Kurpius, 2004; Lee, 2004; National Center for Education statistics [NCES], 2003; Secada, 1992; Tutweiler, 2005).

¹ The term Black will be used to refer to people of the African Diaspora, and to such populations that reside within the United States. Therefore, the term Black will be capitalized to distinguish the racial category and related identity from color. Similarly, the word White will be capitalized when referring to race.

² The terms America and United States are used interchangeably. Accordingly, the term America refers only to the United States of America, and does not reference Canada or South America.

Some research reports that female students are closing the achievement gap with males in mathematics and science (Kerr & Kurpius, 2004; NAEP, 2011). Overall, more women than men graduate from college with a bachelor's degree; however, this has not translated into a significant increase of women in mathematics and science careers. For example, 36% of White women earned a bachelor's degree by age 26, compared to 22% of Black women, 30% of White men, and 12% of Black men (Bowen, 2009). The composition of science and engineering careers in the United States is 18% White women, 1% Black women, 54% White men, and 2% Black men (NSF, 2011). What explains why Black females are nearly twice as likely to complete bachelor's degrees as Black males, but Black males are twice as likely as Black females to be employed in science and engineering careers?

Various studies report that Black girls obtain higher grades, experience fewer grade retentions, value school more highly, report stronger intentions to finish high school, and achieve higher graduation rates than Black boys (Garibaldi, 1992; Graham, Taylor, & Hudley, 1998; Hefner, 2004; Jordan & Cooper, 2003; Mickelson & Greene, 2006; Saunders, Davis, Williams, & Williams, 2004). For example, in a recent report, the College Board (2010) stated that the graduation rate of Black girls was nine percentage points higher than the graduation rate of Black boys, and that Black boys are nearly twice as likely as Black girls to be suspended from high school.

1.1.3 Contribution to the field. Existing literature examines the underrepresentation of women in mathematics and science careers by analyzing postsecondary student outcomes. At this stage, little can be done to increase proficiency in high school mathematics, the basis for success in advanced-level mathematics and science courses.

There is a paucity of nationally representative studies conducted to explore how individual-level, familial-level, and school-level variables impact Black females' proficiency in high school mathematics, as well as predict their enrollment in postsecondary mathematics courses. This study seeks to fill this void.

This study will provide insight valuable to educational leaders and organizations that want to increase the number of Black women in mathematics and science careers. The findings from this study will inform the development of interventions and strategies aimed at increasing the mathematics proficiency of Black females and their enrollment in postsecondary mathematics courses.

1.2 Background

1.2.1 Theoretical framework. The sociology of education examines how public institutions and individual experiences affect education and its outcomes. Pierre Bourdieu and Jean-Claude Passeron (1990) believed that cultural capital explained differences in children's outcomes in France during the 1960s. As first articulated by Bourdieu, cultural capital embodies the forms of education, knowledge, skills, and advantages a person has that give him or her a higher status in society. Parents provide their children with cultural capital by transmitting the attitudes and knowledge needed to succeed in the current educational system.

In "The Forms of Capital" (1986), Bourdieu distinguishes between three types of capital: economic, cultural, and social. Social capital includes resources based on group membership, relationships, networks of influence, and support, and has been used to illuminate the relationship between the micro level of educational experience and the macro level of social forces and structures. Bourdieu posited the role of education was to build a bridge between cultural and social reproduction. This essential bridge is constructed when the educational

system impacts the reproduction of power and relationships between classes. According to Bourdieu, the impact of education on individuals and society is critical, because the reproduction of cultural capital reflects the values and morals of the dominant class. Education neutralizes those values and morals, because it acts as a common denominator for all who acquire it.

James S. Coleman (1988) rejected, as did Bourdieu, the idea that educational attainment and achievement is a product solely of an individual's natural talents. Coleman built upon Bourdieu's framework of social capital by defining it as a public resource serving to enforce the social norms and sanctions within families and communities. The three forms of social capital he identifies are: obligations and expectations, information channels, and social norms. Coleman posits that social capital is not just a property of the elite, and to some degree compensates for the lack of other forms of capital. Social capital is inherent in the relations between and among actors. Therefore, different communities exhibit different forms of social capital. The Jewish wholesale diamond market in New York City, the clandestine 'study circles' of radical student activists in South Korea, and the Kahn El Khalili market owners in Cairo all exhibit social structures that provide resources (social capital) that can be used by the actors to achieve their interests (Coleman, 1988).

According to Coleman (1988) social capital within a family centers on the number of adults and the activities in which they and the children in the family are engaged. Productive social capital at the community level requires parents and schools to work together. This teamwork results in the enforcing of acceptable academic and social behaviors among students to produce academic excellence. How does this sociocultural framework apply to Black females and what factors emerge as predictors of their mathematical proficiency?

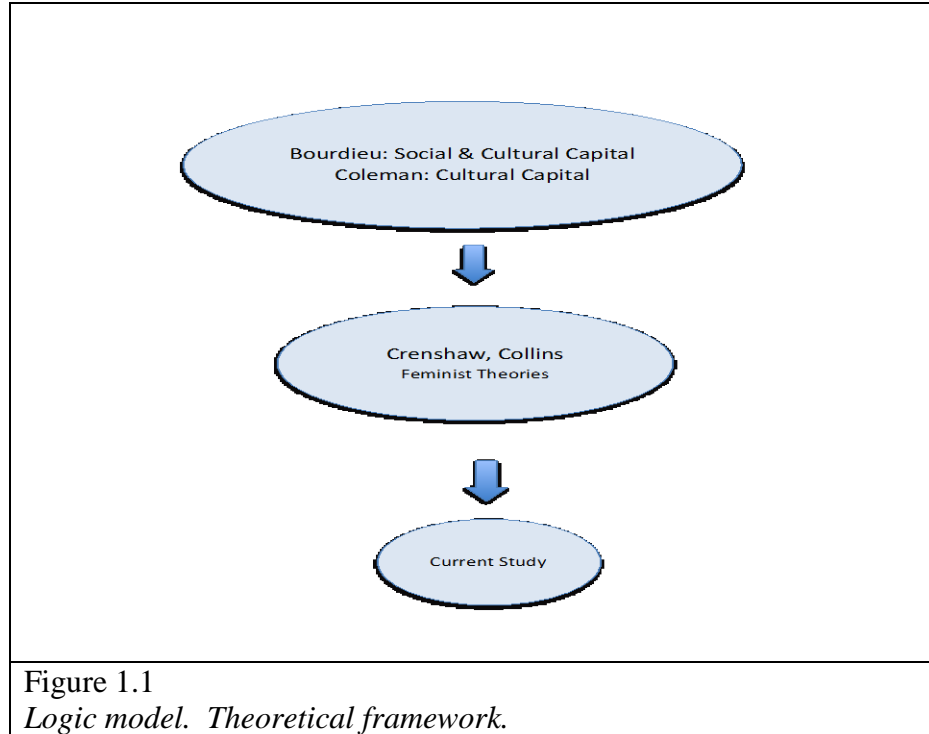
Existing literature examines the mathematical achievement of females and minorities as if all females are White and all Blacks are men. Black females stand at a focal point where two exceptionally powerful and prevalent systems of oppression unite: race and gender.

Intersectionality was first highlighted in 1989 by Kimberle Crenshaw to conceptualize the legal system's gender and racial discrimination. Currently, the theory of intersectionality is applied extensively to examine how interlocking systems of oppression operate on the social structural level of institutions.

Patricia Hill Collins (2000) has articulated a paradigm of intersectionality that includes the theory of standpoint and the concept of the matrix of domination. According to Collins, the matrix of domination refers to the overall organization of power in a society, and any matrix has a particular arrangement of intersecting systems of oppression. These intersecting systems are specifically organized through four interrelated domains of power: structural, disciplinary, hegemonic, and interpersonal.

Institutions of education exposed individuals to the dominant group's standpoint and interests, while at the same time offering literacy and skills that can be used for individual empowerment and social transformation. The promise of empowerment simultaneously requires docility and passivity. Collins advocates the need for safe spaces, "social spaces where Black women speak freely" apart from the hegemonic or ruling ideology (Collins, 2000, p. 12). These safe spaces provide opportunities for self-definition, the first step to empowerment.

One primary safe space is Black females' relationships with one another. These could be informal, such as friends or family, or formal and public, such as Black churches, women's organizations, and educational settings. What individual-level, familial-level, and school-level variables empower Black females to achieve in mathematics?



1.2.2 Literature review. There is a plethora of literature that focuses on the individual-level, familial-level, and school-level factors that impact mathematical achievement. However, much research does not examine the intersection of sex, race, or SES, thereby making the assumption that “all women are White, all Blacks are male, and everyone is from a middle SES level” (Campbell, 1989, p. 96). Research on diverse populations requires studying race, ethnicity, and social class in conjunction with gender. While gender-stereotypes affect all girls, and while race and class discrimination affects all minority groups, there are differential effects. The combined effect of race, gender, and class is greater than the sum of the individual parts (Butler, 1987).

Locus of control and self-concept has been the focus of much research designed to explain the variability in student mathematical achievement (Burlew, 1979; Strayhorn, 2010).

Numerous studies on individual-level variables have included predominately White females and males, and have concluded that interest in mathematics, the perception of mathematics as useful, confidence in learning mathematics, and confidence in one's own abilities all correlate with mathematics persistence and higher achievement (Campbell, 1989; Fennema & Sherman, 1977, 1978; Lim, 2008; Lockheed, Thorpe, Brooks-Gunn, & McAloon, 1985).

In primary school and beyond, gender differences in perceptions of academic ability are evident and reflect traditional sex role stereotypes, handicapping women in mathematics and science (Malcolm, 1984; Meece & Scantlebury, 2006; Parsons, 1983; Swinton et al., 2011). Black girls are doubly affected by racial and gender stereotypes (Schmader, Johns, & Forbes, 2008; Swinton, Kurtz-Costes, Rowley, & Okeke-Adeyanju, 2011). Without intervention, girls' attitudes and self-concept related to these subjects continue to be more negative than those of male students (Kerr & Kurpius, 2004; McGraw, Lubienski, & Strutchens, 2006).

When race and gender were not considered in conjunction, research found that teachers and parents had lower expectations for girls than for boys. In examining the possible origins of these early gender gaps in mathematics, previous researchers looked inside mathematics classrooms and found that teachers tended to hold higher expectations of their male students and to view mathematics as a male domain (Li, 1999). Yet, in contrast to this previous work, recent large-scale studies suggest that teachers actually rate the performance of girls more favorably than the performance of males (Fryer & Levitt, 2010; Robinson & Lubienski, 2011).

Young minority women feel teachers expect more from girls (Campbell & Shackford, 1989; Rist, 1970). Black mothers tend to have higher expectations for their daughters than for their sons (Kunkel & Kennard, 1971; Lewis, 1975; Lopez, 2003; Reid, 1972). However, it may be the gender stereotypes that explain why Black males tend to view their mathematics and

science performances more favorably than do Black females (Evans, Copping, Rowley, & Kurtz-Costes, 2011).

Research on familial-level variables usually examines factors that cannot be manipulated or changed to improve mathematics achievement, such as family education or SES-level (Lockheed et al., 1985). Parents' involvement has an impact on mathematical achievement, whether directly, as in homework, or indirectly, as in setting up and monitoring homework time (Swinton et al., 2009). Various studies indicate that parents' negative experiences with mathematics tend to affect their children's motivation to learn mathematics (Martin, 2000).

Literature on school-level factors impacting the achievement of Blacks and females in mathematics highlights the importance of teacher-student relationships. Because Black students tend to have high levels of anxiety and self-inadequacy in their endeavor to succeed in mathematics (Ryan & Ryan, 2005), students' feelings of belonging and the quality of student-teacher relations have been shown to be central components of students' intrinsic motivation to learn (Ames, 1992; Cooks, 2003; Oldfather & Dahl, 1994).

Research has linked teacher expectations for student performance and classroom instructional practices with the mathematics performance of students (Tyler & Boelter, 2008). The expectations of teachers are even more important for students who have been historically discriminated against, and for those who have had historically fewer opportunities to learn meaningful mathematics (Paul, 2005; Silver, Smith, & Nelson, 1995). Teachers may expect less in terms of ability and performance from students in high concentration minority schools, since their focus may be on less academically successful students (Flores, 2007).

1.3 Methodology

1.3.1 Procedures. Social scientists and policy makers have studied extensively the Black-White disparities in mathematics achievement in American schools. However, there has been a preoccupation among researchers to use White middle-class males as the standard by which all others are measured.

Existing research on the White-Black and gender gaps in mathematical achievement can be organized under five general theoretical explanations: (1) social psychological (affective) factors (attitude, self-concept, self-confidence); (2) student aspirations and academic preparation; (3) extra-familial influences (extra-curricular activities, peers); (4) parental support (income, involvement); and (5) school characteristics (percent minority, private, teachers). It should be noted that these theoretical explanations have not been tested empirically to examine how they impact Black females' proficiency in high school mathematics, as well as how they predict their enrollment in postsecondary mathematics courses.

Data employed in the present study is drawn from the National Education Longitudinal Study of 1988 (NELS:88), conducted by the National Center for Education Statistics (NCES). NELS:88 is a clustered, two-stage, stratified national sample with a total of 24,599 eighth-graders surveyed in the base year, 1988.

NELS:88 consists of four follow-ups to the original 1988 study. The first follow-up was conducted in 1990 when the students, if progressing normally, would be in the tenth grade. Dropouts were replaced with students of similar backgrounds. The second follow-up came in 1992, when students, if progressing normally, would be graduating high school. The third follow-up, conducted in 1994, allowed the study to assess who had graduated high school, dropped out of high school, continued on to post-secondary institutions, or entered the

workforce. The year 2000 marked the fourth and final follow-up, and was designed to analyze the impact of post-secondary education and/or progress in the workforce. The 2000 survey also determined if respondents had become parents. Data were also collected from parents (1998 and 1992) and teachers (1988, 1990, and 1992).

This dissertation will focus on Black female students in four of the five waves of the collected data: the Base Year (1988), the First Follow-up Study (1990), the Second Follow-up Study (1992), and the Third Follow-up Study (1994). Preliminary analysis shows that approximately 700 Black females meet the selection criteria.

Ordinary least squares (OLS) and multiple regression analyses (Agresti & Finlay, 2008; Raudenbush & Bryk, 2001; Singer & Willet, 2003) will be employed to determine which independent variables have the greatest impact on predicting proficiency in high school mathematics as well as enrollment in postsecondary mathematics courses.

This dissertation consists of six chapters. Chapter Two will review the literature surrounding the social forces that impact Black females' views on, and experiences with, education, as well as their ability to academically succeed in mathematics. In particular, Chapter Two will examine the research surrounding race, gender, and education, specifically social forces that have indelibly impacted the relationship between Black females and education as posited by Crenshaw, Collins, and other feminist theorists.

Chapter Three will outline the specifics of the methodology employed for this dissertation.

Chapter Four reveals, in detail, the statistical findings germane to this quantitative study. This chapter will discuss the individual-level, familial-level, and school-level variables that

impact Black female students' proficiency in high school mathematics, as well as predict their enrollment in postsecondary mathematics courses.

Chapter Five will present an analysis of the results presented in Chapter Four. The second task of this chapter will be to discuss the results as they relate to and interconnect with the various theoretical and ideological perspectives discussed in the literature review.

Chapter Six will present conclusions, implications, and recommendations. This chapter will revisit the need to identify antecedent individual, familial, and school factors, those prior to postsecondary attendance, which can lead to interventions aimed at increasing Black female students' proficiency in high school mathematics, the basis for success in advanced-level mathematics and science courses.

Chapter Two: Literature Review

2.1 Introduction

Chapter One, Introduction and Background, examined literature and research on the Black-White and gender differences in mathematics achievement. One theoretical framework is not sufficient to examine the complexities of Black females' experiences with high school mathematics, so components of distinct, though complementary, strands of literature have been joined. Specifically, this chapter employs feminist and sociocultural theoretical frameworks to analyze the literature concerning factors that impact Black females' achievement in high school mathematics.

2.2 Theoretical Framework

2.2.1 *The forms of capital.* The sociology of education examines how public institutions and individual experiences affect education and its outcomes. Pierre Bourdieu and Jean-Claude Passeron (1990) believed that cultural capital explained differences in children's outcomes in France during the 1960s. As first articulated by Bourdieu, cultural capital embodies the forms of education, knowledge, skills, and advantages a person has that give him or her a higher status in society. Parents provide their children with cultural capital by transmitting the attitudes and knowledge needed to succeed in the current educational system.

In "The Forms of Capital" (1986), Bourdieu distinguishes between three types of capital: economic, cultural, and social. Although boundaries between the forms of capital are often unclear, each form of capital is an important resource for the acquisition of academic credentials.

Economic capital refers to financial resources, income and wealth, that can be immediately converted into money or institutionalized in the form of property rights (Bourdieu, 1986). Parents' economic capital affords them the ability to equip their children with important

physical capital (books, computers), or to live in neighborhoods with quality public schools. Economic capital also affords parents the opportunity to enrich their children's educational experiences through academic and cultural activities that take place outside of schools. These include attending academic preparation courses, visiting museums and colleges, and participating in arts, music, and athletic activities. One benefit of economic capital is that it can be transmitted across generations and provides a head start in the accumulation of economic wealth for future generations.

Cultural capital refers to the norms, tastes, values, language, and knowledge of high status groups that influence academic success. Cultural capital is specific to the economic class to which an individual belongs. Bourdieu distinguishes three forms of cultural capital: embodied, objectified, and institutionalized (Bourdieu, 1986).

Embodied cultural capital consists of both the consciously acquired and the passively "inherited" properties of one's self. It begins early in a child's life and over time develops a person's habitus, one's disposition to take action based on one's knowledge of the social structure and experiences of what is possible within it. Linguistic capital, which is the mastery of and relation of language, is an example of embodied cultural capital. It represents a means of communication and self-presentation acquired from one's surrounding culture (Bourdieu, 1990).

Objectified cultural capital consists of physical objects that are owned, such as books, music, and works of art. Objectified cultural capital can be sold for economic profit, or it may be purchased as a symbol of conveying cultural capital. Although one may purchase objectified cultural capital, such as a painting, an individual must possess the proper foundation of conceptual or historical culture in order to "consume" or understand the cultural meaning of the painting.

Institutionalized cultural capital comprises institutional recognition, usually in the form of academic credentials or qualifications. This concept of capital is most prominently realized in the labor market, in which a large variety of cultural capital is expressed in a single qualitative or quantitative measurement and compared against others' similarly measured cultural capital. The institutional recognition process thereby eases the conversion of cultural capital to economic capital by serving as a guideline that sellers can use to describe their capital, and that buyers can use to describe their need for that capital.

Social capital refers to resources based on group membership, relationships, and networks of influence and support, and has been used to illuminate the relationship between the micro level of educational experience and the macro level of social forces and structures. Bourdieu posited the role of education was to build a bridge between cultural and social reproduction. This essential bridge is constructed when the educational system impacts the reproduction of power and relationships between classes. According to Bourdieu, the impact of education on individuals and society is critical because the reproduction of cultural capital reflects the values and morals of the dominant class. Education neutralizes those values and morals because it acts as a common denominator for all who acquire it.

James S. Coleman (1988) rejected, as did Bourdieu, the idea that educational attainment and achievement is a product solely of an individual's natural talents. Although Bourdieu was primarily interested in the ways in which powerful elites retained their privilege, Coleman posited that social capital was not just a property of the elite, and to some degree compensated for the lack of other forms of capital.

Building upon Bourdieu's framework, Coleman examined the interconnectedness of social disadvantage, community, and schooling, and defined social capital as a public resource

serving to enforce the social norms and sanctions within families and communities. He identified obligations and expectations, information channels, and social norms as resources that constitute social capital for actors. Therefore, social capital is inherent in the relations between and among actors, and communities exhibit different forms of social capital. The Jewish wholesale diamond market in New York City, and the clandestine study circles of radical student activists in South Korea, both exhibit social structures that provide resources (social capital) that can be used by the actors to achieve their interests (Coleman, 1988).

In the process of negotiating a sale, the merchants in New York City's wholesale diamond market will give another merchant a bag of stones to examine at his leisure with no formal insurance that the latter will not substitute inferior stones. The insurance that is necessary to facilitate the market transactions is inherent in the social structure. The merchants are Jewish, with a high degree of intermarriage, live in the same community in Brooklyn and attend the same synagogues. If a merchant stole stones that were in his temporary possession, he would lose family, religious, and community ties. The strength of these ties makes elaborate and expensive bonding and insurance practices unnecessary.

In 1986, the *International Herald Tribune* contained an article about the clandestine study circles of radical student activists in South Korea (Coleman, 1988). The social structure of the study circles illustrates two types of social capital. The study circles were comprised of students who attended the same high school or church, and this constituted a form of social capital. The study circles also served as the basic organizational unit for demonstrations and other protests. It was this organization that made political activities possible, so it was another form of social capital.

Social capital can produce both economic and noneconomic outcomes. In his book, *Human Capital*, published in 1964, Becker illustrated how investment in an individual's education and training was similar to business investments in physical capital, such as factories and machines. Thus, human capital is a means of production into which additional investment yields additional output. Human capital can be converted into high levels of educational attainment and occupational status. Human capital is substitutable, but not transferable, like land, labor, or fixed capital.

Coleman (1988) posited that social capital within a family centers on the number of adults and the activities in which they and the children in the family are engaged. Productive social capital at the community level requires parents and schools to work together, and this network should possess intergenerational ties. In other words, parents should know their children's friends, as well as the friends' parents. This teamwork results in the enforcing of acceptable academic and social behaviors among students in order to develop their skills, knowledge, and abilities (human capital).

In *Caswell County Training School, 1933-1969: Relationship between Community and School*, Emilie V. Siddle Walker provided an example of productive social capital that existed in southern African-American schools prior to desegregation in 1969 (Walker, 1993). This ethnographically approached study of the Caswell County Training School (CCTS) used eighty open ended interviews with former teachers, students, parents, and administrators to uncover the collaborative relationship and mutual ownership between the school and the community, and their common mission to provide quality education for their children. The parents relied upon the school's expertise, guidance, and academic vision. The school depended on the parents' financial contributions, advocacy, and home-front support. The opportunity to dialogue both in

the school environment (parents attended school activities), and in the community (teachers visited churches), was important in keeping the school-community relationship strong. This network of social relations, social capital, enabled the parents and teachers of CCTS to work together to enforce acceptable academic and social behaviors among students in order to produce academic excellence.

2.2.2 Intersectionality. Feminist theories can help elucidate how power, authority, and knowledge play out in the classroom and may explain how Black girls regard themselves as learners of mathematics. Black females stand at a focal point where two exceptionally powerful and prevalent systems of oppression unite: race and gender. Intersectionality was first highlighted in 1989 by Kimberle Crenshaw to conceptualize the legal system's gender and racial discrimination. Currently, the theory of intersectionality is applied extensively to examine how interlocking systems of oppression operate on the social structural level of institutions.

Patricia Hill Collins (2000) articulated a paradigm of intersectionality that included the theory of standpoint and the concept of the matrix of domination. According to Collins, the matrix of domination refers to the overall organization of power in a society, and any matrix has a particular arrangement of intersecting systems of oppression. These intersecting systems are specifically organized through four interrelated domains of power: structural, disciplinary, hegemonic, and interpersonal. The structural domain consists of the social structures such as religion, the economy, and law. This domain is slow to change and usually does so as a result of large-scale social upheavals. For example, Blacks received the right to vote on February 3, 1870, but it wasn't until the Voting Rights Act of 1965 ended Jim Crow Law that the majority of Blacks actually voted.

The disciplinary domain manages oppression and consists of bureaucratic organizations, which control and organize human behavior through routinization, rationalization, and surveillance. Organization protocol hides the effects of racism and sexism under the canopy of efficiency, rationality, and equal treatment. Although discrimination based on race has been outlawed, what are systematically excluded are facts such as Blacks earning only 58.7 percent of what Whites earn (U.S. Census Bureau, 2010).

The hegemonic domain legitimates oppression and links the structural, disciplinary, and interpersonal domains. Ideology and consciousness come together to create the cultural sphere of influence: language, images, values, and ideas that are produced or reproduced through school curricula and textbooks, religious teachings, mass media, community cultures, and family histories. Authority functions because people believe it.

The interpersonal domain is comprised of personal relationships and the various interactions that are a part of everyday life. The interpersonal domain is how an individual sees herself and her experiences. Institutions of education expose individuals to the dominant group's standpoint and interests, while at the same time offering literacy and skills that can be used for individual empowerment and social transformation. The promise of empowerment simultaneously requires docility and passivity.

Collins advocated the need for "safe spaces," social spaces where Black women speak freely apart from the hegemonic or ruling ideology (Collins, 2000). These safe spaces provide opportunities for self-definition, the first step to empowerment. One primary safe space is Black females' relationships with one another. These could be informal, such as friends or family, or formal and public, such as Black churches, women's organizations, and educational settings. These social networks represent social capital as articulated by Coleman (1988).

To contextualize Black women's experiences with the American educational system, and their need for "safe spaces," two ethnographic studies are discussed.

In the Spring 2010 issue of the *Harvard Educational Review*, Carmen Kynard wrote an article entitled "From Candy Girls to Cyber Sista-Cipher: Narrating Black Females' Color-Consciousness and Counterstories in and out of School." In this narrative ethnography, Kynard examined the intersection of race, class, and gender in education, and discussed the need for present day "hush harbors," virtual safe spaces that afford Black women opportunities to share and create knowledge, and to find their voices in the hostile environments of secondary and postsecondary institutions.

As a professor at a large, diverse, urban university, Kynard found that many young Black women were reluctant to speak in her classes. A meeting with one student after class turned in to many more hours of conversations, and soon other Black women joined the dialogue. Eventually, communication was conducted on-line with careful planning in order to remain invisible to the institution, thereby creating a hush harbor. The e-mail discussions between Kynard and the group of thirteen young women, aged nineteen through twenty-three-years old, took place during the school months for almost three years. All of the young women, representatives of the African Diaspora, were first-generation college students, worked a minimum of thirty hours per week, and finished their college studies in five or six years. Their conversations, often in Black vernaculars, were about school, school assignments, school discussions, school writing, and the racist or Western assumptions underlying the tasks they had been given in school. These hush harbors worked against the University's determination of proper White discourses. This article presented an example of the safe spaces that provide Black

women opportunities for self-definition. These hush harbors provided the social capital needed to acquire human capital, namely educational credentials.

In “The Road Not Taken: Two African American girls’ Experiences With School Mathematics,” Jae Hoon Lim (2008) argued that ethnicity and class had a profound impact upon African American girls’ motivation and identity in relation to school mathematics. This study also explored how a teacher’s creation and maintenance of a set of cultural norms and expectations in her mathematics class impacted the attitudes towards learning mathematics for the two girls whose ethnic and class backgrounds were different from their teacher’s.

The mathematics teacher of both girls, Mrs. Oliver, was White, in her late 40s, and had begun teaching mathematics not on the basis of her professional training or performance, but due to a chronic shortage of mathematics teachers in the county. She was described as extremely hardworking, highly confident, and enthusiastic. Mrs. Oliver regarded mathematics as static knowledge, and strictly enforced classroom rules to control behavior and monitor students’ progress; at the end of most days, Mrs. Oliver developed a sore throat.

Many of the students, mostly from White middle-class backgrounds, interpreted her strict and firm attitude as an expression of her high expectations for her students. However, students from working-class backgrounds, many of whom were Black, doubted the fairness of school and felt uncomfortable and insecure with Mrs. Oliver’s strict disciplinarian approach. Race and class became a predictor of how students would experience her math class.

Stella was a high-achieving African American girl from a working-class background, and an exemplary student in Mrs. Oliver’s advanced mathematics class. She was a meticulous and hardworking student who always sat in the back of the class near the door and rarely asked

questions or spoke in public. During interviews with Stella, Lim learned of the joyless, anxiety-laden experience of Stella's mathematics classes.

Stella felt inadequate and inferior when she compared herself to the other higher achieving White girls. Although Stella's test scores were comparable to other high achieving White peers in her class, Mrs. Oliver did not recommend Stella for the seventh-grade pre-algebra class. Mrs. Oliver viewed Stella as an unmotivated, passive learner, whose career trajectory would possibly involve attendance at a two-year college.

Rachel was an outspoken African American girl in Mrs. Oliver's second period regular mathematics class, which was comprised of students who had scored the lowest on the initial assessment test. Rachel was described as having a high-level of confidence, a leader among African-American girls, with the ability to control her environment, particularly her relationships with teachers. Rachel and Mrs. Oliver had a very positive relationship based on mutual respect that was based on "...each other's authorities at the school" (Lim, 2008, p. 310). Although Rachel was an "A" student in the regular math class, she was not considered a high-achieving math student. Mrs. Oliver adjusted the curriculum to what she perceived to be the learning ability of each class.

The path to a higher level of mathematics was not an option for either girl. Lim explained how the lack of social and cultural capital had negative consequences for the two girls' academic success in mathematics. Mrs. Oliver represented the dominant culture: White, middle-class, and male by virtue of having been selected to teach mathematics. Lim's study presented a plausible explanation as to why, and how, African American girls have been under-represented in advanced-level math classes. The study revealed the deeply embedded inequity that exists in

the current structure and practice of teaching and learning of school mathematics in the United States.

The ethnographic studies conducted by Kynard and Lim shed light on Black women's experiences with the American educational system. Although the strength of qualitative research is its usefulness in explaining why things happen, the small sample sizes limit the extent to which the results are generalizable.

What follows is an examination of literature, both qualitative and quantitative, that relates to Black females and mathematics.

2.3 Literature Review

Mathematics is the one subject of the American school curriculum that is both feared and revered by the general public: feared, because it is too hard, and revered, because it is believed to be reserved for the intelligentsia. For the last three decades, researchers have consistently reported that, on average, Black students have not scored as high on national standardized tests of mathematics achievement as have White students. There is a widely accepted racial hierarchy of mathematics ability that places Asian and White students at the top, and Black, Native American, and Latino students at the bottom (Martin, 2009). This hierarchy contributes to the belief that Black, Native American, and Latino students are mathematically illiterate. By accepting the racial hierarchy of mathematics abilities, researchers have framed their goals of closing the racial achievement gaps in mathematics around moving Blacks and other minorities from their perceived positions of mathematical illiteracy to new positions of mathematics literacy occupied by White and Asian students. Researchers are not the only ones affected by the racial hierarchy; students often internalize these beliefs leading to stereotype threat.

Stereotype threat is the threat of being perceived as fitting a negative stereotype or the fear that poor performance confirms that stereotype. The power of stereotypes may explain the persistent gap in scores between Black and White students, and males and females, on standardized tests. For example, if a woman performs poorly on a math test, then her performance would be consistent with the stereotype that men are better in math. When the threat of confirming a stereotype is removed (for example, by labeling the test unimportant, or by not indicating one's sex or race), the performance of the stereotyped group member often improves (Steele & Aronson, 1995).

In 1995, Steele and Aronson conducted a study that focused on how the threat posed by stereotypes affects Blacks. They hypothesized that, whenever Black students took on an intellectual task, such as an SAT, they faced the prospect of confirming widely held suspicions about their brainpower. To investigate their hypothesis, the psychologists gave 44 Stanford undergraduates questions from the verbal part of the Graduate Record Exam. Only one of the two groups was asked to identify their race. The Black students who identified their race scored significantly worse than the Blacks who did not identify their race, and significantly worse than all the White students. The Black students who were not asked to identify their race had scores that equaled their White counterparts.

Literature examining the Black-White and gender achievement gaps in mathematics generally includes discourse surrounding racial and gender stereotypes, as well as socioeconomic (SES), which is the metric used as a proxy for class. SES is an economic and sociological combined total measure of a person's work experience and family's economic and social position, based on income, education, and occupation. In order to fully examine the Black

females' attainment in high school mathematics, SES information is incorporated in this discussion.

There is a plethora of literature that focuses on the individual-level, familial-level, and school-level factors that impact mathematical achievement. However, much research does not examine the intersection of sex, race, or SES, thereby making the assumption that “all women are White, all Blacks are male, and everyone is from a middle SES level” (Campbell, 1989, p. 96).

Existing research on the White-Black and gender gaps in mathematical achievement can be organized under five general theoretical explanations: (1) social psychological (affective) factors (attitude, self-concept, self-confidence); (2) student aspirations and academic preparation; (3) extra-familial influences (extra-curricular activities, peers); (4) parental support (income, involvement); and (5) school characteristics (percent minority, private, teachers).

2.3.1 Individual-level factors. Research has focused on affective factors such as attitude, self-concept, and self-confidence to explain achievement in mathematics. The findings from numerous studies, which included predominately White females and males, have concluded that enjoyment of—and interest in—mathematics, the perception of mathematics as useful, confidence in learning mathematics, and confidence in one's own abilities all correlate with mathematics persistence and higher achievement for both male and female students (Campbell, 1989; Fennema & Sherman, 1977, 1978; Lim, 2008; Lockheed, Thorpe, Brooks-Gunn, & McAloon, 1985).

Affective factors have also been the focus of much of the research explaining the gender differences in student mathematical achievement. Males, for example, tended to have more

positive self-concept with respect to mathematics than females (Burlew, 1979; Lubienski, McGraw et al., 2004; Strayhorn, 2010).

In her book, *Counting Girls Out*, Valerie Walkerdine (1998) reported the outcomes of a ten-year theoretical and empirical investigation of girls' attainment in mathematics. Although the book illustrated how working-class girls in Britain were underachieving in mathematics, irrespective of their talents and abilities, *Counting Girls Out* has been instrumental in re-theorizing 'the gender problem' for the educational research community worldwide.

Walkerdine formulated a reproduction cycle of gender inequality in mathematics education that begins with the dominant cultural definition of masculinity, one that encompasses the power of rationality and mathematical thinking. The discursive production of femininity is antithetical to masculine rationality to the extent that femininity does not equal math, but is equated to poor performance, even when a girl or woman is performing well. This 'truth' results in a lack of equal opportunities in school mathematics, and lowered expectations for girls, with some girls' successes being discounted. Society internalizes these distorted stereotypes and myths, and girls' perceptions of math as a male domain lower their mathematical confidence and self-concept, thereby contributing to girls' lower attainment and participation in mathematics. The vicious cycle continues as mathematics becomes a 'critical filter' controlling access to advanced study in math and better-paid professional occupations, not only in science and technological careers, but also in other occupations such as commerce and finance. The 'critical filter' effect leads to many women taking lower paying jobs, thereby maintaining the gender inequality in the UK and other Anglophone countries. This gender inequality reinforces the dominant cultural definition of masculinity and the cycle continues. Walkerdine argued that

women's underachievement and under-participation in mathematics, where they exist, play an important role in reproducing the gender inequality and gender stereotyping.

In primary school and beyond, gender differences in perceptions of academic ability are evident and reflect traditional sex role stereotypes, handicapping women in mathematics and science (Malcolm, 1984; Meece & Scantlebury, 2006; Parsons, 1983; Swinton et al., 2011). Studies have shown that gender and ethnic differences in mathematics performance and self-esteem are more pronounced at the high school level (Bornholt, Goodnow, & Cooney, 1994; Daley, 1991; Kohr, 1987; Ogbu, 1987).

Research regarding the 'gender problem' generally attributes girls' lack or difference to 'nature' (lack of spatial ability) or 'nurture' (socialization). To investigate the 'nurture' argument, Walkerdine (1998) carried out studies of girls at home (four-year olds), and in nursery and infant schools. She concluded that girls were not failing in the early years.

To further study the gender differences, Walkerdine observed a group of students from the top classes of two junior high schools as they transitioned to secondary schools. One major conclusion from this investigation was that girls, on average, were outperforming boys. Because research on girls' performance in mathematics tends to treat girls as a monolithic group, Walkerdine advocates for the investigation of within group characteristics, such as race and class.

For example, when examining two 10-year old girls who were failing at math, Walkerdine found that, although both girls had achieved equal scores on a standardized math test, their teachers judged their poor grades in mathematics in class-specific ways. Julie, from a middle-class background, was perceived as having a "block" that could be cured. However, Patsy, from a working-class background, was considered "stupid." One major finding from

Walkerdine's study is that working-class White girls are under-performing in mathematics irrespective of their talents and abilities.

Swinton et al. (2011) conducted a longitudinal study of 115 African American youths to examine the gendered nature of motivational beliefs. The researchers found that in both grades 8 and 11, African American boys were more likely than African American girls to attribute their success in mathematics to high ability. These results indicated that, even before high school, girls perceived themselves as less competent in mathematics than boys. The study also found declines in motivation in mathematics across the high school years for both genders. The researchers advocated that future research should examine the within gender differences when studying achievement beliefs in Black youth.

McClendon and Wigfield (1998) conducted a study that examined the differences in the achievement-related beliefs of African American adolescents about math and science. The 102 participants were involved in an academic enrichment program. Results showed that the boys had more positive beliefs about their abilities and expectations for success in mathematics and science than the girls did.

The second category for examining extant literature on achievement in mathematics is student aspirations and academic preparation.

In most of the literature reviewed, the terms "aspirations" and "expectations" were used interchangeably to indicate students' desire to go to college. Students' educational aspirations have been shown to impact educational achievement. Jencks, Crouse, and Mueser (1983) found that students with college plans tended to enroll in college preparatory courses and thereby increased their achievement scores. According to Astone and McLanahan, "...high aspirations are a critical factor predicting educational achievement" (1991, p. 310).

Using the NELS:88 data, Solorzano (1992) studied the aspirations of Black and White eighth-graders. He asked students how far in school they thought they would get. One of the major findings from his analysis was that the percentage of females aspiring to go to college was greater than the percentage of males, regardless of socioeconomic status or race (Solorzano, 1992).

In 1994, Hanson used the 1986 High School and Beyond (HSB) data to study a sample of students who demonstrated early indication for attending college. She found that young women were more likely than young men to aspire to go to college. However, males and individuals from upper socioeconomic status backgrounds were more likely to have high educational expectations and score higher on standardized tests in mathematics.

Signer, Beasley, and Bauer (1997) conducted a study of 100 White and Black urban secondary students in New York City that compared students in compensatory mathematics courses with students in non-compensatory mathematics courses. Educational aspirations were gauged by responses to a question that asked how far students expected to get in school. The researchers classified responses to the question as either 'less than college,' or 'college or beyond' (Signer, Beasley, & Bauer, 1997, p. 380). They found that, of the students taking compensatory mathematics courses, African Americans showed a six times greater chance of aspiring for college than their White counterparts.

In this review of the literature, prior academic achievement, mathematics course-taking and grade retention will constitute academic preparation. Prior academic achievement in math is strongly correlated with subsequent achievement in math for Black high school students (Adams & Singh, 1998; Strayhorn, 2010; Tyson et al., 2007). Adam and Singh used data from NELS to study 1,766 Black tenth grade students and concluded that prior academic achievement had a

strong influence on future achievement. In their study, students' scores on eighth grade standardized tests in reading, mathematics, science, and social studies measured prior academic achievement. Strayhorn (2010) also used NELS data to study the mathematics achievement of Black students in tenth grade. He concluded that prior success in mathematics was associated with future success in mathematics. Furthermore, literature reports that high school mathematics scores are one of the most powerful predictors of postsecondary educational attainment (Tyson et al., 2007).

Advanced math course-taking in high school, particularly those above the critical threshold of Algebra II, is a strong determinant of college attendance and subsequent degree completion (Adelman 1994, 1999). In 1994, Adelman examined the educational and occupational choices that 1972 high school graduates made over the succeeding 15 years. He used data collected for the National Longitudinal Study of the High School Class of 1972 (NLS-72), which tracked a representative sample of 22,652 individuals using survey questionnaires and school records. Findings from that study revealed that college admission, access to course-taking in college, and eligibility for majors were often determined by the mathematics courses taken in high school (Adelman, 1994, 1999).

Signer et al. (1997) found that female students enrolled in non-compensatory mathematics courses were the least likely to desire further enrollment in additional advanced mathematics courses. However, Catsambis (1994) used data from NELS to explore the process by which women's participation in mathematics began to drop during adolescence. She found that White female students in tenth grade had the highest enrollment in the high-ability math classes, such as Algebra I, Algebra II, and Geometry. Catsambis also reported that African American male students had the highest enrollment in low-ability math classes.

Literature reports that Black students are more likely than Whites to meet only minimum high school requirements in mathematics, with many Blacks stopping at Algebra I or Geometry (Riegle-Crumb & Gordosky, 2010; Strutchens et al., 2004). Black students and economically disadvantaged students experience unequal access to opportunities to learn advanced mathematics, which explains why Black students are not as likely to complete advanced mathematics courses, such as Algebra II and Pre-calculus (Woolley et al., 2010).

Riegle-Crumb and Gordosky (2010) used data from the Education Longitudinal Study of 2002 to analyze the math achievement gap among students who take the more demanding high school math classes, such as Pre-Calculus and Calculus. Their findings suggest that African American youth from segregated schools fare the worst in terms of closing the achievement gap with their White peers. The authors stressed the need for more research that explicitly focuses on the factors that inhibit minority/majority parity at the top of the secondary curricular structure.

Despite the deficiency discourse surrounding Blacks in mathematics, Ellington and Frederick (2010) researched factors that shaped Blacks students' success in mathematics. Using the case study methodology with eight high achieving Black undergraduate mathematics majors, they found that students' success in mathematics was shaped by their participation in accelerated academic programs, access to advanced mathematics coursework, as well as support from their family, peers, and teachers.

A meta-analysis of 44 studies related to the effects of grade-level retention on elementary and junior high school pupils revealed the negative effects on mathematics achievement and other educational outcomes (Holmes & Matthews, 1984). In 2010, Reynolds used data from the Chicago Longitudinal Study (CLS) to investigate whether grade retention was associated with participation in postsecondary education. The study sample included 1,367 participants using

data for grade retention and educational attainment by age 24. Findings indicated that grade retention was associated significantly with lower rates of participation in postsecondary education.

The third major category for examining the literature on achievement in mathematics is extra-familial influences. Literature on peer influence and extra-curricular activities is discussed. Research shows that students who have friends with college plans are more likely to have a strong predisposition for college attendance (Carpenter & Western, 1982; Falsey & Heyns, 1984). Carpenter and Western conducted a longitudinal study that examined the effects of the perceived influence of significant others and self-concept on college aspirations. Researchers found that parent, teacher, and peer influence had a major impact for both males and females.

Prior research has shown that students who participate in extra-curricular activities have higher grades than those who do not. Broh (2002) used data from NELS to test the effect of participation in extracurricular activities on high school achievement. He concluded that participation in interscholastic sports promoted student development and social ties among students, parents, and schools. Hawkins and Mulkey (2005) used NELS to examine the relationship between athletic participation among middle school African American students and academic achievement. The analysis found that sports participation was positively associated with Black eighth-grade students' aspirations to enroll in academic or college preparatory programs in high school, complete high school, and attend college.

2.3.2 Familial-level factors. Research on familial-level factors typically examines factors that cannot be manipulated or changed to improve mathematics achievement, such as family education or SES-level (Lockheed et al., 1985). Evidence suggests that the academic achievement of African Americans is less sensitive to parental education and other aspects

measures of SES than the achievement levels of White youth (McGraw et al., 2006). Catsambis (1994) found that within racial-ethnic groups, SES was not related to gender differences in math achievement or attitudes. However, Adams & Singh (1998) concluded that SES had a statistically significant effect on the mathematics achievement of Black high school students.

There is an abundance of literature on parental involvement, particularly regarding elementary and middle school children. Parents' involvement has an impact on mathematical achievement, whether directly, as in homework, or indirectly, as in setting up and monitoring homework time (Swinton et al., 2009). However, research on the impact of parental involvement on high school student outcomes has been inconclusive. Adams and Singh (1988), controlling for an extensive array of intervening variables, found that parental involvement did not have a significant effect on the mathematics achievement of Black high school students in tenth grade.

In 2005, Yan and Lin used ordinary least square regressions on the NELS:88 data set to examine the relationships of three dimensions of parental involvement (family obligations, family norms, and parent information networks) on twelfth grade students' mathematics achievement. They explored ways in which parental involvement varied across Caucasian, African American, Hispanic, and Asian students' mathematical achievement. Their findings indicated that parent involvement was generally a salient indicator for explaining the mathematics achievement of Caucasian students, but not as effective for minority students.

However, Strayhorn (2010) found that parental involvement was a significant predictor of math achievement in tenth grade for Black high school students. These conflicting results in the literature may be due to the definition of parental involvement employed. Research shows academic preparation counters the reduced college enrollment for at-risk students, especially when coupled with strong support from parents and other influential adults (Horn, 1997).

2.3.3 School-level factors. The 1966 report *Equality of Education Opportunity* (Coleman Report) is considered the most important education study of the twentieth century and credited with fueling the debate on the effects of schools (Coleman, 1968). The Coleman Report, named after the head researcher and sociologist, James S. Coleman, was commissioned by the U.S. Office of Education in accordance with the Civil Rights Act of 1964. Using data from over 600,000 students and teachers across the country, one of the researchers' main findings was that academic achievement was less related to the quality of a student's school than to the social composition of the school. In accordance with the issues of racial relations and equality that were prevalent in the 1960s, this conclusion set the stage for busing, because it was deemed that disadvantaged Black children learned better in well-integrated classrooms. Other equally important findings that were eclipsed found that the student's sense of control of his or her environment and future, the verbal skills of teachers, and the student's family background also impacted the student's academic achievement.

Although busing failed to achieve the integration that Coleman posited would improve the academic achievement of Black students, findings from his 1966 report still ring true today. Youth attending schools with a higher share of minority students tend to have lower levels of academic achievement as measured by scores on standardized tests (Burriss et al., 2007). Further, students in segregated Non-White schools are nearly six times more likely to attend a low-resourced school than students attending schools where 90%-100% of the school population is White (Frankenberg, Lee, & Orfield, 2003).

In 1981, the third and final Coleman Report, *Public and Private School*, was published. Coleman found that, after controlling for family background factors, private and Catholic schools provided a better education than did public schools (Coleman, 1981). Although these findings

continue to be hotly debated, there is current literature that supports the benefits of private schools (Attewell & Lavin 2009; McGraw et al., 2006).

To assess the merits of private schools, Attewell and Lavin (2009) used data from the City University of New York (CUNY) and National Longitudinal Survey of Youth (NLSY). They found that children who attended private schools had better educational outcomes from elementary school through college than otherwise equivalent children who did not attend private school. On average, children who were sent to private school also showed bigger improvements in reading and mathematics. These differences were statistically significant after controlling for such family characteristics as race, class, and mother's IQ (Attewell & Lavin, 2009).

Recent literature on school-level factors impacting the achievement of Blacks and females in mathematics highlights the importance of teacher-student relationships. Because Black students tend to have high levels of anxiety and self-inadequacy in their endeavor to succeed in mathematics (Ryan & Ryan, 2005), students' feelings of belonging, and the quality of student-teacher relations, have been shown to be central components of students' intrinsic motivation to learn (Ames, 1992; Cooks, 2003; Oldfather & Dahl, 1994).

Research has linked teacher expectations for student performance and classroom instructional practices with the mathematics performance of students (Tyler & Boelter, 2008). The expectations of teachers are even more important for students who have been historically discriminated against, and for those who have had historically fewer opportunities to learn meaningful mathematics (Paul, 2005; Silver, Smith, & Nelson, 1995). Teachers may expect less in terms of ability and performance from students in high concentration minority schools, since their focus may be on less academically successful students (Flores, 2007).

Tenenbaum and Ruck (2007) used four quantitative meta-analyses to examine whether teachers held race-based and ethnic-based expectations for their students. The findings from three of the four analyses suggest that teachers favor European American students more than African American and Latino/a students.

2.4 Contributions to the Field

While gender-stereotypes affect all girls, and while race and class discrimination affects all minority groups, there are differential effects. The combined effect of race, gender, and class is greater than the sum of the individual parts (Butler, 1987). The subtle and blatant reminders of racial stereotypes affect Black students, and Black girls are doubly affected by race and gender stereotypes (Schmader, Johns, & Forbes, 2008; Swinton, Kurtz-Costes, Rowley, & Okeke-Adeyanju, 2011).

The failure to consider the correlation of gender, ethnicity, SES and achievement has resulted in oversimplified analysis and perpetuation of gender and ethnic biases (Cohen, Pettigrew, & Riley, 1972; Coleman, 1988; Fleming & Malone, 1983; Grant & Sleeter, 1986; Stanic & Reyes, 1986).

For example, McGraw et al. (2006) used the results from the National Assessment of Educational Progress (NAEP), 1990-2003, to analyze gender gaps in math achievement. Gender gaps favoring males occurred within White and Hispanic students, but gender gaps favoring males were non-existent for Black students. In fact, the gender gap favored Black females, especially within the content stands of fourth and eighth grade geometry and fourth grade data analysis (McGraw, Lubienski, & Strutchens, 2006).

There is a paucity of research examining the interactions among ethnicity, gender, and mathematics achievement level in high schools (American Association of University Women,

1991; Beaudry, 1992, Grant & Sleeter, 1986; Richman, Clark, & Brown, 1985). Research on diverse populations requires studying race and social class in conjunction with gender. When the intersections of these variables are not examined, within group differences are not recognized, and interactions cannot be identified. However, the difficulty in examining race, social class, and gender is a function of the diminishing samples sizes caused by the creation of subgroups within subgroups.

This study aims to determine individual-level, familial-level, and school-level variables that impact Black female students' proficiency in high school mathematics as well as predict their enrollment in postsecondary mathematics courses.

Chapter Three: Methods

3.1 Introduction

The preceding chapters discussed literature and research on the Black-White and gender differences in mathematics achievement. Additionally, Chapters One and Two employed feminist and sociocultural theoretical frameworks to analyze social factors impacting the achievement of Black females in mathematics. Chapter Three describes the methodology utilized in this study.

This dissertation examines individual-level, familial-level, and school-level variables that impact Black female students' proficiency in high school mathematics, as well as predicts their enrollment in postsecondary math courses. Data employed in the present study is drawn from the National Education Longitudinal Study of 1988 (NELS) conducted by the National Center for Education Statistics (NCES). NELS is a nationally representative panel study that followed a cohort of American eighth-graders twelve years as they progressed through high school on to employment or postsecondary education.

Ordinary least squares (OLS) and multiple regression analyses (Agresti & Finlay, 2009; Raudenbush & Bryk, 2002; Singer & Willet, 2003) will be employed to determine which independent variables have the greatest impact on predicting proficiency in high school mathematics as well as enrollment in postsecondary math courses.

The remainder of this chapter is divided into four sections. The first section, *Dataset*, provides a detailed description of how NELS was designed, how respondents were selected, and which components were included in the current study. Second, *Analytic Samples*, describes how and why the analytical samples were constructed for analysis. The third section, *Measures*, provides a detailed description of the outcome and predictor variables used in the analyses. In

addition, this section will address how this dissertation dealt with missing data. Finally, *Analytic Strategy*, describes the data analysis methods and strategy.

3.2 Dataset

The National Education Longitudinal Study of 1988 (NELS) was conducted by the United States Department of Education's National Center for Education Statistics (NCES). NELS is a nationally representative panel study that followed the same cohort of American eighth-graders twelve years as they progressed through high school on to employment or postsecondary education. NELS consists of a base year study, 1988, and four follow-ups. The base year study utilized a two-stage stratified probability design to select a nationally representative sample of eighth-graders attending American public and private schools in 1988. Schools constituted the first stage of sampling. A random sample of about 23 students within each of the 1,052 participating American public and private schools constituted the second stage of sampling (Ingels et al., 2002). The resulting base year student sample of eighth-graders was 24,599.

The first follow-up was conducted in 1990 when the students, if progressing normally, would be in the tenth grade. The second follow-up came in 1992, when students, if progressing normally, would be graduating high school. The third follow-up, conducted in 1994, provided data on who had graduated high school, dropped out of high school, continued on to postsecondary institutions or entered the workforce. The year 2000 marked the fourth and final follow-up, referred to as the final wave, and was designed to analyze the impact of postsecondary education and progress in the workforce.

In addition to following the same cohort of 1988 eighth-graders throughout the four follow-up years, NCES "freshened" the original sample in 1990 and 1992 by surveying a

nationally representative sample of students who were not included in the previous waves of the study. An example of a 1990 “freshened” student is a student who, in 1990, was a tenth-grader attending an American high school, but was not represented in the 1988 base year survey, either because he or she was not in the eighth grade, or was in the eighth grade but not living in the United States in 1988. An example of a 1992 “freshened” student is a student who was neither an eighth-grader attending an American middle school in 1988, nor a tenth-grader attending an American high school in 1990, but who, in 1992, was a twelfth-grader enrolled in an American high school.

The refreshing process allows for the 1990 and 1992 follow-ups to be nationally representative samples of American tenth and twelfth-graders in their respective years, thus providing researchers the opportunity to conduct cross-sectional and longitudinal analyses on the eighth, tenth, or twelfth grade cohort. In other words, the refreshing process yields a representative pool of American middle school and high school students of diverse backgrounds and educational experiences by accounting for the influx of immigrants since 1965, particularly from Latin America and the Caribbean (Kalmijn & Kraaykamp, 1996), and the reality that many students do not progress in sequential grade order and therefore may be out of their model grade (Hauser, 2000).

Students completed surveys and curriculum-sensitive cognitive tests during the eighth, tenth, and twelfth grades. These surveys provided information about students’ educational, vocational, and personal development. Students were asked about their academic experience, educational aspirations and expectations, future career plans, peer relationships, extracurricular activities, student-teacher interactions, parental support and involvement, family formation, and

work experience. Additionally, NCES conducted surveys of parents in 1998 and 1992, and conducted teacher surveys in 1988, 1990, and 1992.

3.3 Analytic Samples

The original sampling design of NELS involved a clustered stratified national probability sample of 1,052 American middle public and private schools from which 24,599 students were interviewed in the base year 1988. Most of those students were re-interviewed in another four rounds of data collection in the years 1990, 1992, 1994, and 2000.

To examine the specific research questions under investigation, variables belonging to four out of five waves of data collection were selected, that is: Base-Year Study (NELS:88), First Follow-up Study (NELS:88/1990), Second Follow-up Study (NELS:88/1992), and Third Follow-up Study (NELS:88/1994). Subsequently, since the interest was focused on Black Non-Hispanic female students, this specific sub-sample was selected and the total number of cases at this preliminary stage was 582. However, since the present study is focused on the math achievement of Black Non-Hispanic female students in twelfth grade (year 1992), and the successive pursuit of credit bearing math courses taken during their Postsecondary Education (PSE) as recorded in the year 1994, the number of cases decreased. This sample attrition is due to the fact that only a fraction of the female students who had a score on the 1992 standardized mathematics test (first dependent variable; see below) continued with college/university education and therefore took math classes during PSE (which represents the second dependent variable, see below for further details). Moreover, another cause of the drop in the analytical subsample size was missing data. When less than the full 582 responded to a particular question, the number of respondents is noted by $n=$.

While the small sample size afforded by NELS:88 presents a potential area of concern for this study, the lack of research on large samples of children of color is a problem that has been raised by other researchers (Jeynes, 2005). Despite these concerns, many researchers have utilized NELS:88 data to disaggregate Black male and/or female students (Battle, 1998; Hawkins & Mulkey, 2005; Jeynes, 2005; Stewart, 2007).

Battle (1998) utilized NELS:88 to disaggregate Black students of lower and higher socioeconomic status in his study on educational outcomes for Black students in single versus dual-parent households. Hawkins and Mulkey (2005) utilized NELS:88 to disaggregate Black males and Black females for their study on the impact of gender on the association between sport participation and students' educational opportunities and outcomes. Jeynes (2005) utilized NELS:88 to disaggregate Black students whom he parceled out into four socioeconomic sub-groups to study the effects of parental involvement on academic achievement of Black youth. Carpenter and Ramirez (2007) used data from NELS:88 to disaggregate racial groups for their examination of academic achievement gaps among Black, White, and Hispanic students. Additionally, Stewart (2007) utilized NELS:88 to disaggregate Black students in order to examine the extent to which individual-level and school structural variables predict academic achievement among a sample of tenth grade Black students.

3.4 Measures

What follows is the list of variables selected to conduct the study. After the dependent variables, the operational definitions of the independent predictors are presented.

3.4.1 Dependent variables. The aim of this dissertation is to examine individual-level, familial-level, and school-level variables that impact Black female students' proficiency in high school mathematics as well as predict their enrollment in postsecondary math courses. Studies

have shown that gender and ethnic difference in mathematics performance and self-esteem are more pronounced at the high school level (Ogbu, 1987; Tyson et al., 2007). Furthermore, literature reports that high school math scores are one of the most powerful predictors of postsecondary educational attainment (Tyson et al., 2008). In accordance with these findings, the following dependent variables were selected:

1) 'Mathematics Standardized Score in 1992' is a variable already existing in the NELS Dataset (F22XMSTD 'Mathematics Standardized Score') measuring the score the students had on the standardized test of mathematics in the Spring semester of twelfth grade in 1992 (Second Follow-up).

2) 'Respondent Took Math Class(es) during Post-Secondary Education (PSE)' is a dummy variable referring to the question asking respondents 'During the Last Two Years, Have You Had One or More Courses in Non-Remedial Math? (REGMATH)' with value 0='no' and 1='yes.' This question was only asked in the follow-up survey in 1994 to those respondents who enrolled in a college or university that was not a vocational, technical, or trade school. This, in part, explains the drop in the valid number of cases on this variable as compared, for example, to the previous dependent measure.

3.4.2 Independent variables. The independent variables were conceptualized in consonance with the research question and thus consist of three sets of predictors. The first set is individual-level variables including students' educational aspirations, mathematics achievement and course-taking patterns, extra-curricular activities, and educational aspirations of respondents' peers.

3.4.3 Individual-level variables. Students' educational aspirations and desire to go to college are related to educational achievement (Astone & McLanahan, 1991; Hanson, 1994;

Jencks, Crouse, & Mueser, 1983). In 1992, Solorzano found that the percentage of females aspiring to go to college was greater than the percentage of males regardless of socioeconomic status or race.

A review of the literature on students' educational aspirations influenced the selection of the original NELS variable 'Respondent's Educational Aspiration' (BYS45 'How Far in School Do You Think You Will Get'). The range runs from: 1 = 'won't finish high school'; 2 = 'will graduate from high school, but won't go any further'; 3 = 'will go to vocational, trade, or business school after high school'; 4 = 'will attend college'; 5 = 'will graduate from college'; 6 = 'will attend a higher level of school after graduating from college.'

Prior academic achievement in math is strongly correlated with subsequent achievement in math for Black high school students (Adams & Singh, 1998). This research supports the selection of 'Math Grades from 6th- until 8th-Grade.' This variable refers to the grades that the respondent obtained in math classes taken at school in the time period between sixth and eighth grades. The original variable was reversed in order to have higher scores reflect higher grades and, by doing so, the range of the rescaled variable is: 1='mostly below Ds'; 2= 'mostly Ds'; 3= 'mostly Cs'; 4= 'mostly Bs'; 5= 'mostly As.'

Advanced math course-taking in high school, particularly those above the critical threshold of Algebra II, is a strong determinant of college attendance and subsequent degree completion (Adelman 1994, 1999). Mathematics course-taking in high school is often utilized as a 'gatekeeping' determinant, since it is widely used as a factor for college admission, access to subsequent course-taking in college, and eligibility for major course of study (Adelman, 1999). Black students are more likely than Whites to meet only minimum high school course-taking requirements in math, with many Blacks stopping at Algebra I or Geometry (Strutchens et al.,

2004). This prior research lends support to the inclusion of the next two independent variables, ‘Amount of Coursework Taken in Geometry (in years)’ and ‘Amount of Coursework Taken in Algebra II (in years).’

‘Amount of Coursework Taken in Geometry (in years)’ is a variable measuring how much coursework in geometry the respondent took in the time period between the beginning of ninth grade and the end of the school year in which the interview took place, tenth grade. The range of this variable runs from 0 = ‘none’ through 4 = ‘2 years,’ proceeding by increments of 0.5 = ‘half year.’ The original NELS variable is F1S22D (‘From the Beginning of 9th-Grade to the End of This School Year, How Much Coursework Will You Have Taken in Geometry’).

‘Amount of Coursework Taken in Algebra II (in years)’ is a variable, similar to the previous one, measuring how much coursework in Algebra II the respondent took from the beginning of ninth grade through the end of tenth grade. Its range is from 0 = ‘none’ to 4 = ‘2 years,’ proceeding by increments of 0.5 = ‘half year,’ and the original NELS variable is, in this case, F1S22E (‘From the Beginning of 9th-Grade to the End of This School Year, How Much Coursework Will You Have Taken in Algebra II’).

Prior research (Broh, 2002) has shown that students who participate in extra-curricular activities have higher grades than those who do not. ‘Time Spent on Extracurricular Activities’ is a respondent’s estimate of the amount of weekly hours that he or she dedicates to school sponsored activities that are not part of the academic curriculum. The original question asks ‘In a Typical Week, How Much Total Time Do You Spend on All School Sponsored Extracurricular Activities (Sports, Clubs, or Other Activities)?’ (NELS item F2S31). The range of this measure is from: 0 = ‘none’; 1 = ‘less than one hour per week’; 2 = ‘one to four hours per week’; 3 = ‘five

to nine hours per week'; 4 = '10-14 hours per week'; 5 = '15-19 hours per week'; 6 = '20-24 hours per week'; 7 = '25 hours or more per week.'

A meta-analysis of studies related to the effects of grade-level retention on elementary and junior high school pupils revealed the negative effects on mathematics achievement and other educational outcomes (Holmes & Matthews, 1984; Reynolds, 1992). 'Respondent Has Been Held Back' is an original dichotomous variable taken from the NELS Dataset referring to the survey item 'F2N16 (Has Respondent Ever Been Held Back a Grade in School?)' whose values are 0 = 'no' and 1 = 'yes.'

Students who have friends with college plans are more likely to have a strong predisposition for college attendance (Carpenter & Western, 1982; Falsey & Heyns, 1984). This research guided the selection of the next two independent variables related to the educational aspirations of respondents' peers.

'Part of Respondent's Friends Who Plan to Attend a Two-Year Community College or Technical School' is a rescaled variable based on the NELS item 'F2S69D (How Many of Your Friends Plan to Attend a Two-Year Community College or Technical School?).' It ranges from: 0 = 'none of them'; 1 = 'a few of them'; 2 = 'some of them'; 3 = 'most of them'; 4 = 'all of them.'

'Part of Respondent's Friends Who Plan to Attend a Four-Year College or University' is similar to the previous variable, and is used to estimate the part of respondent's friends who chose to continue their education by attending a four-year college or university (F2S69E 'How Many of Your Friends Plan to Attend a Four-Year College or University?'). The range for this variable runs from 0 = 'none' through 4 = 'all of them.'

3.4.4 Familial-level variables. The second set of independent variables includes measures that reflect aspects of familial influence, namely ‘parental income’ and ‘parental involvement.’

Evidence suggests that the academic achievement of African Americans is less sensitive to parental education and other aspects measures of SES than the achievement levels of White youth (McGraw et al., 2002). Within racial-ethnic groups, SES is not related to gender differences in math achievement or attitudes (Catsambis, 1994). Further, Adams and Singh (1998) concluded that SES had a statistically significant effect on achievement in mathematics for Black high school students. SES is a combination of variables including occupation, wealth, education, place of residence and income. This study utilizes ‘Parental Involvement’ as a measure of a family’s social and cultural capital, and ‘Family Income’ as a measure of a family’s economic capital.

‘Family Income Rescaled’ is a measure of family economic capital whose original range (from “1 = \$0” to “15 = \$200,000 or more”) was rescaled to a new one ranging from: 0 = ‘\$0’; 1 = ‘less than \$1,000’; 2 = ‘\$1,000-\$2,999’; 3 = ‘\$3,000-\$4,999’; 4 = ‘\$5,000-\$7,499’; 5 = ‘\$7,500-\$9,999’; 6 = ‘\$10,000-\$14,999’; 7 = ‘\$15,000-\$19,999’; 8 = ‘\$20,000-\$24,999’; 9 = ‘\$25,000-\$34,999’; 10 = ‘\$35,000-\$49,999’; 11 = ‘\$50,000-\$74,999’; 12 = ‘\$75,000-\$99,999’; 13 = ‘\$100,000-\$199,999’; 14 = ‘\$200,000 or more.’

There is an abundance of literature on parental involvement, particularly regarding elementary and middle school children. However, research on the impact of parental involvement on high school student outcomes has been inconclusive. Adams and Singh (1988), controlling for an extensive array of intervening variables, found that parental involvement did not have a significant effect on the mathematic achievement of Black high school students in

tenth grade. However, Strayhorn (2010) found that parental involvement was a significant predictor of math achievement in tenth grade for Black high school students. These conflicting results in the literature may be due to the definition of parental involvement that is employed.

For this study, 'Parental Involvement' is a scale obtained by combining a set of four original variables aiming to assess whether or not respondent's parents 'Attended a School Meeting' (BYS37A), 'Spoke to Teacher/Counselor' (BYS37B), 'Visited Respondent's Class' (BYS37C), 'Attended a School Event' (BYS37D). Before adding the scores of those variables, the original coding was changed to 0 = 'no' and 1 = 'yes,' and this produced a measure with a range running from '0' through '4.'

3.4.5 School-level variables. Finally, the third set of predictor variables were used to measure the school characteristics. Two measured aspects of the school setting and the last measured teachers' perceptions of students' ability to learn the material.

In 2009, Attewell and Lavin used data from the City University of New York (CUNY) and National Longitudinal Survey of Youth (NLSY) surveys to assess the merits of private schools. They found that children who attended private schools had better educational outcomes from elementary school through college than otherwise equivalent children who did not attend private school. On average, children who were sent to private school also showed bigger improvements in reading and mathematics. These differences were statistically significant after controlling for such family characteristics as race, class, and mother's IQ (Attewell & Lavin, 2009). 'Private School' is a dummy variable indicating whether the school the respondent attended is private (coded 1) or public (coded 0). The original measure is G8CTRL 'School Control Composite.'

Students in segregated Non-White schools are nearly 6 times more likely to attend a low-resourced school than students attending schools where 90%-100% of the school population is White (Frankenberg, Lee, & Orfield, 2003). Further, youth attending schools with a higher share of minority students tend to have lower levels of academic achievement as measured by scores on standardized tests (Burriss et al., 2007).

‘Percent Minority in School’ is a continuous variable taken from the original dataset (G8MINOR ranges from: 0 = ‘none’ to 7 = ‘91-100%.’) created to measure the percentage of students considered minority in the school attended by the respondent. The range runs from: 0 = ‘0%’; 1 = ‘1-5%’; 2 = ‘6-10%’; 3 = ‘11-20%’; 4 = ‘21-40%’; 5 = ‘41-60%’; 6 = ‘61-90%’; 7 = ‘91-100%.’

Research has linked teacher expectations for student performance and classroom instructional practices with the mathematics performance of students (Tyler & Boelter, 2008). The expectations of teachers are even more important for students who have been historically discriminated against, and those who have had historically fewer opportunities to learn meaningful math (Paul, 2005; Silver, Smith, & Nelson, 1995). Teachers may expect less in terms of ability and performance from students in high concentration minority schools, since their focus may be on less academically successful students (Flores, 2007). This last independent variable was chosen to examine teachers’ perceptions of students’ learning abilities.

‘Students Incapable of Learning Material’ is a six-point Likert Scale belonging to the teacher questionnaire based on the item ‘F1T4_1I (Many of the Students I Teach Are Not Capable of Learning the Material I am Supposed to Teach Them)’ has been rescaled. Its new range runs from: 0 = ‘strongly disagree’; 1 = ‘disagree’; 2 = ‘disagree somewhat’; 3 = ‘agree somewhat’; 4 = ‘agree’; 5 = ‘strongly agree.’

3.5 Analytic Strategy

Ordinary least squares (OLS) and multiple regression analyses will be employed to determine which independent variables have the greatest impact on predicting Black females' proficiency in high school mathematics, as well as their enrollment in postsecondary math courses.

Model 1 enters individual-level variables into a regression equation to examine their impact on the dependent variable, 'Mathematics Standardized Score in 1992.' In the NELS:88 data, this category includes variables such as 'Respondent's educational aspirations' and 'Amount of Coursework Taken in Geometry (in years).' Signer et al. (1997) found that female students enrolled in non-compensatory mathematics courses were the least likely to desire further enrollment in additional advanced mathematics courses.

In Model 2, familial-level variables from NELS:88 data, such as 'Family Income' and 'Parental Involvement,' are added to the regression model. Existing research suggests that parents' involvement impacts mathematical achievement, whether directly, as in homework, or indirectly, as in setting up and monitoring homework time, particularly in elementary and middle school settings (Hong & Ho, 2005; Swinton et al., 2009). Yan's (2005) findings indicated that for African American students, family involvement was not as powerful an explanation of achievement on twelfth grade math scores as it was for Caucasian students. A study on Black high school students found that students whose parents attended school meetings earned higher math achievement scores in tenth grade (Strayhorn, 2010).

Model 3 will examine the impact of school-level variables. In the NELS:88 data, this category includes variables such as 'Percent Minority in School,' and 'Students Incapable of

Learning Material.’ How does the addition of school-level variables impact the overall regression model?

Literature on school-level factors impacting the achievement of Blacks and females in mathematics highlights the importance of teacher-student relationships. Black students whose teachers praise them for their effort earn higher math achievement scores. But, on the other hand, Black students whose teachers recommend “work not school” earn lower math achievement scores (Strayhorn, 2010). The 1991 U.S. Department of Education’s publication, *What Schools Can Do to Improve Math & Science Achievement by Minority & Female Students*, recommended that teachers should demonstrate high expectations for all students’ mathematics achievement and lead classroom discussions on ethnic and gender stereotyping and its repercussions for mathematics performance.

One of the goals of this dissertation is to examine the multivariate influence that selected individual-level, familial-level, and school-level variables have on the two dependent variables: proficiency in high school mathematics in 1992, and enrollment in postsecondary mathematics courses. Logistic regression was utilized to determine which variables were useful in predicting Black females’ enrollment in postsecondary mathematics courses.

Chapter Four: Results

4.1 Introduction

This chapter explores the following research question: How do individual-level (aspirations), familial-level (support), and school-level (school characteristics) variables impact Black female students' proficiency in high school mathematics as well as predict their enrollment in postsecondary math courses?

To answer this question, this dissertation utilizes data from the National Education Longitudinal Study (NELS) conducted by the National Center for Education Statistics (NCES). NELS allows for the tracking of a cohort from the eighth grade in 1988 to 12 years later, in 2000, when most had been out of high school for close to eight years. The base year, 1988 surveyed eighth grade students, as well as their parents and teachers. Throughout this chapter, the term Black females refers to the 582 Black Non-Hispanic females who participated in the NELS survey and, therefore, are the population discussed. When less than the full 582 responded to a particular question, the number of respondents is noted by n=.

The data analysis was conducted in three stages. Descriptive statistics were first computed to characterize the sample. Second, correlation analyses were then conducted to estimate the magnitude and direction of statistical relationships among the variables. The last stage consisted of regression analyses to estimate the influence of individual-level, familial-level, and school-level variables on the two dependent variables: 'Mathematics Standardized Score in 1992' and 'Respondent Took Math Class(es) during Post-Secondary Education (PSE).'

4.2 Univariate Analysis

Table 4.1 presents descriptive statistics of means, standard deviations, ranges, and descriptions of variables for Black Non-Hispanic females. This table allows for univariate

analysis of the distribution of single variables. Table 4.1 provides a synopsis of the 582 Black Non-Hispanic females analyzed in this dissertation.

4.2.1 Dependent variables. Mathematics Standardized Score in 1992: Test scores ranged from 30.42 through 67.22 on the standardized mathematics test taken by the 1988 cohort expected to be high school seniors in 1992. The average score for Black females (n=437) was 45.46, indicating that, on average, Black females scored in the mid-range of overall scores.

Respondent Took Math Class(es) During PostSecondary Education (PSE): By 1994, two years after the 1988 cohort's expected graduation from high school, 68% of Black females (n=316) had taken a non-remedial math course.

4.2.2 Independent variables.

4.2.2.1 Individual-level variables. Eight set of variables were chosen to measure student characteristics.

On a scale of 1-6, the average ranking for Black females (n=573) on 'Respondent's Educational Aspirations' was 4.76. This indicates the average Black female planned to attend college and, to a lesser degree, graduate from college.

The scale for 'Math Grades from 6th - until 8th - grade' was reordered to range from lowest grades to highest grades. In accordance with this ascending scale, the average math grades for Black females (n=564) was 3.88. This indicates that the relative mean for Black females was above C, but just below B.

The average score for Black females (n=506) on 'Amount of Coursework Taken in Geometry (in years)' was 0.46. This indicates that on average Black females took a half-year of geometry.

The average score on ‘Amount of Coursework Taken in Algebra II (in years)’ for Black females (n=499) was 0.22. This indicates that, on average, Black females did not take Algebra II.

The average number of hours Black females (n=493) spend on extracurricular activities was 1.65. This indicates that Black females spent between 1 = ‘less than 1 hour/week’ and 2 = ‘between 1 and 4 hours/week.’

Seventeen percent of Black females (n=527) indicated that they had been held back a grade in school.

The mean value for the analytical sample on ‘Part of Respondent’s Friends Who Plan to Attend a Two-Year Community College or Technical School’ is 1.54 which is between level 1 = ‘a few of them’ and 2 = ‘some of them.’

The relative mean for the analytic sample on ‘Part of Respondent’s Friends Who Plan to Attend a Four-Year College or University’ is 2.50, which is in between level 2 = ‘some of them’ and 3 = ‘most of them.’

4.2.2.2 Familial-level variables. The two variables, ‘Family Income’ and ‘Parental Involvement’ were used. The relative mean on the rescaled variable ‘Family Income’ is 6.87, which is between level 6 = ‘\$10,000-\$14,999’ and level 7 = ‘\$15,000-\$19,999.’

As created by NCES, ‘Parental Involvement’ is a scale obtained by combining a set of four original variables aiming to assess whether or not (0 = yes, 1 = no) respondent’s parents ‘attended a school meeting,’ ‘spoke to teacher/counselor,’ ‘visited respondent’s class,’ and/or ‘attended a school event.’ This variable has been rescaled and the mean for Black females (n=451) was 2.15. This indicates that, on average, parents of Black females participated in two of these four school activities.

4.2.2.3 School-level variables. Type of school, percent minority, and teachers' perceptions of students' ability to learn the material were the school-level variables that were measured.

Twelve percent of Black females attended private school.

For the 'Percent Minority in School,' on a scale of 0-7, the average ranking for Black females (n=580) was 5.02. This indicates that the average Black female attended schools with at least a 41% minority population and as much as a 90% minority population.

On a scale of 0-5, the teacher's response to 'Students Incapable of Learning Material,' the average ranking for Black Females (n=458) was 1.98. This indicates that, on average, teachers perceptions were between 1 = 'disagreed' and 2='somewhat disagreed' with the statement.

Table 4. 1
Means, Standard Deviations, Ranges and Description of Variables for Black-Non Hispanic Females

Variable	N	Mean	S.D.	Range	Description: NELS Variable NAME and Label
<i>Dependent Variables</i>					
Mathematics Standardized Score in 1992	437	45.46	9.19	30.42 – 67.22	F22XMSTD ‘F2 Mathematics Standardized Score’
Respondent Took Math Class/es During Post Secondary Education (PSE)	316	0.68	0.47	0 – 1	REGMATH ‘During the Last Two Years, Have You Had One or More Courses in Non-Remedial Math?’
<i>Individual-level Variables</i>					
Respondent’s Educational Aspirations	573	4.76	1.22	1 – 6	BYS45 ‘How Far in School Do You Think You Will Get?’
Math Grades from 6 th - until 8 th -Grade	564	3.88	0.98	1 – 5	BYS81B ‘Math Grades from Grade 6 until Now’
Amount of Coursework Taken in Geometry (in years)	506	0.46	0.52	0 – 2	F1S22D ‘From the Beginning of 9 th -Grade to the End of This School Year, How Much Coursework Will You Have Taken in Geometry’
Amount of Coursework Taken in Algebra II (in years)	499	0.22	0.43	0 – 2	F1S22E ‘From the Beginning of 9 th -Grade to the End of This School Year, How Much Coursework Will You Have Taken in Algebra II’
Time Spent on Extracurricular Activities	493	1.65	1.55	0 – 7	F2S31 ‘In a Typical Week, How Much Total Time do You Spend on All School Sponsored Extracurricular Activities (Sports, Clubs, or Other Activities)?’
Respondent Has Been Held Back	527	0.17	0.37	0 – 1	F2N16 ‘Were You Held Back (Made to Repeat) a Grade in School?’
Part of Friends Who Plan to Attend a Two-Year Community College or Technical School	443	1.54	1.05	0 – 4	F2S69D ‘How Many of Your Friends Plan to Attend a Two-Year Community College or Technical School?’
Part of Friends Who Plan to Attend a Four-Year College or University	446	2.50	1.09	0 – 4	F2S69E ‘How Many of Your Friends Plan to Attend a Four-Year College or University?’

Variable	N	Mean	S.D.	Range	Description: NELS Variable NAME and Label
<i>Familial-level Variables</i>					
Family Income Rescaled	517	6.87	2.92	0 – 14	BYFAMINC ‘Yearly Family Income’
Parental Involvement	451	2.15	1.24	0 – 4	Sum of 4 Items: <u>from</u> BY37A ‘Respondent’s Parents Attended a School Meeting’ <u>thru</u> BY37D ‘Respondent’s Parents Attended a School Event’
<i>School-level Variables</i>					
Private School	582	0.12	0.33	0 – 1	G8CTRL ‘School Control Composite’
Percent Minority in School	580	5.02	1.61	0 – 7	G8MINOR ‘Percent Minority in School’
Students Incapable of Learning Material	458	1.98	1.51	0 – 5	F1T4_1I ‘Many of the Students I Teach Are Not Capable of Learning the Material I am Supposed to Teach Them’

4.3 Bivariate Analysis

Table 4.2 presents the results from T-tests performed on the dummy variables 'Respondent Had Been Held Back' and 'Private School' (Table 4.1) to determine whether their mean scores on the dependent variable 'Mathematics Standardized Score in 1992' are significantly different. As it relates to the population of Black Non-Hispanic females analyzed in this study, the bivariate analysis reveals that being held back a grade in school had a statistically significant impact on the standardized math scores at the .001 level. This indicates that, on average, Black females who were not held back a grade did better on the math standardized test in 1992 ($\bar{x} = 47.03$) than Black females who were held back a grade ($\bar{x} = 39.35$). Attending private school proved to have a statistically significant impact at the .01 level on the dependent variable. This indicates that, on average, Black females who attended private schools did better on the math standardized test in 1992 ($\bar{x} = 48.97$) compared to Black females who did not attend private schools ($\bar{x} = 45.01$).

Table 4. 2
Comparison of Means on Mathematics Standardized Score in 1992 by Independent Variables

<i>Independent Variables</i>	Mathematics Standardized Score in 1992 (i_n in parentheses)
<i>Respondent Has Been Held Back</i>	
No	47.03 ^{***} (338)
Yes	39.35 (56)
<i>Private School</i>	
No	45.01 ^{**} (387)
Yes	48.97 (50)

** p = .01

*** p = .001

Note: Within each predictor on the dependent variable, the superscript of the level of statistical significance is placed just on one of the two categories to indicate that the relative mean scores are statistically different from each other.

Regarding the continuous variables in Table 4.1, Table 4.3 presents Pearson's Correlations that were performed to analyze their statistical significance on the dependent variable 'Mathematics Standardized Score in 1992.' While Pearson's r , or the correlation coefficient, measures the association between continuous variables, that measurement is an estimate of the positive or negative linear relationship a given independent variable has with the dependent variable. As it relates to the population of Black Non-Hispanic females analyzed in this study, the Pearson's Correlations revealed the following:

'Respondent's Educational Aspirations' had a moderate to weak positive impact at the .01 level on math standardized test scores in 1992.

'Math Grades from 6th- until 8th-Grade' had a moderate to weak impact on math standardized test scores in 1992, and a weak positive impact on 'Respondent's Educational Aspirations.' The correlations were statistically significant at the .01 level.

'Amount of Coursework Taken in Geometry (in years)' had a moderate positive impact on math standardized test scores in 1992, a weak positive impact on both 'Respondent's Educational Aspirations,' and 'Math Grades from 6th-until 8th-Grade.' The correlations were statistically significant at the .01 level.

'Amount of Coursework Taken in Algebra II (in years)' had a moderate to weak positive impact statistically significant at the .01 level on both 'Math Standardized Test Scores in 1992' and 'Amount of Coursework Taken in Geometry (in years).'

'Time Spent on Extracurricular Activities' had a weak positive impact on 'Math Standardized Test Score in 1992,' with statistical significance at the .01 level.

'Part of Respondent's Friends Who Plan to Attend a Two-Year Community College or Technical School' had a weak negative impact on 'Math Standardized Test Score in 1992,'

'Respondent's Educational Aspirations,' 'Math Grades from 6th-until 8th-Grade,' 'Amount of Coursework Taken in Geometry (in years),' and 'Amount of Coursework Taken in Algebra II (in years).' All correlations were statistically significant at the .01 level.

'Part of Respondent's Friends Who Plan to Attend a Four-Year College or University' had a weak positive impact level on 'Math Standardized Test Score in 1992,' and 'Respondent's Educational Aspirations,' statistically significant at the .01 level.

'Family income' had a moderate positive impact at the .01 level on 'Math Standardized Test Score in 1992' and a moderate to weak impact on 'Respondent's Educational Aspirations,' 'Amount of Coursework Taken in Geometry (in years),' and 'Part of Respondent's Friends Who Plan to Attend a Four-Year College or University.'

'Parental Involvement' had a weak positive impact at the .01 level on 'Math Standardized Test Score in 1992,' 'Respondent's Educational Aspirations,' 'Amount of Coursework Taken in Geometry (in years),' 'Part of Respondent's Friends Who Plan to Attend a Four-Year College or University,' and 'Family Income.'

'Percent Minority in School' had weak negative impact at the .05 level on 'Math Standardized Test Score in 1992.'

'Students Incapable of Learning Material' had a weak negative impact on 'Math Standardized Test Score in 1992,' but it was not statistically significant.

Table 4. 3
Pearson's Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Mathematics Standardized Score in 1992	1	---	---	---	---	---	---	---	---	---	---	---
Respondent's Educational Aspirations	.35**	1	---	---	---	---	---	---	---	---	---	---
Math Grades from 6 th - until 8 th -Grade	.40**	.12**	1	---	---	---	---	---	---	---	---	---
Amount of Coursework Taken in Geometry (in years)	.53**	.24**	.25**	1	---	---	---	---	---	---	---	---
Amount of Coursework Taken in Algebra II (in years)	.37**	.17**	.08	.36**	1	---	---	---	---	---	---	---
Time Spent on Extracurricular Activities	.30**	.22**	.13**	.18**	.12*	1	---	---	---	---	---	---
Part of Friends Who Plan to Attend a Two-Year Community College or Technical School	-.22**	-.13**	-.13**	-.21**	-.16**	-.09	1	---	---	---	---	---
Part of Friends Who Plan to Attend a Four-Year College or University	.21**	.29**	.04	.19**	.13*	.18**	-.00	1	---	---	---	---
Family Income	.37**	.25**	.12**	.20**	.15**	.08	-.09	.25**	1	---	---	---
Parental Involvement	.29**	.28**	.07	.21**	.18**	.18**	-.16**	.19**	.26**	1	---	---
Percent Minority in School	-.10*	-.08	.00	.04	-.03	-.07	.05	.04	-.13**	.02	1	---
Students Incapable of Learning Material	-.07	.01	.02	-.12*	-.08	-.06	-.01	.00	-.01	-.00	.10*	1

* p = .05

** p = .01

4.4 Multivariate Analysis

One of the goals of this dissertation is to examine the multivariate influence that selected individual-level, familial-level, and school-level variables have on the two dependent variables that represent proficiency in high school mathematics in 1992, and enrollment in postsecondary mathematics courses. Ordinary least squares (OLS) and multiple linear regression analyses were employed to determine which independent variables have the greatest impact on predicting Black females proficiency in high school mathematics. Logistic regression was utilized to determine which variables were useful in predicting Black females' enrollment in postsecondary mathematics courses.

Table 4.4 presents Unstandardized Regression Coefficients for the dependent variable 'Mathematics Standardized Score in 1992 (N=194).' Three multivariate linear regression models, Model 1, Model 2, and Model 3 are presented in this table.

Model 1 will examine the impact of individual-level variables. In the NELS:88 data, this category includes variables such as 'Respondent's educational aspirations' and 'Amount of Coursework Taken in Geometry (in years).' The findings from a 1997 study conducted by Signer, Beasley, and Bauer, indicated that "...low-SES African American students enrolled in compensatory mathematics courses, as well as high-SES African Americans enrolled in non-compensatory mathematics courses, were up to seven times more likely than their White counterparts to show interest in advanced mathematics courses."

In Model 2, familial-level variables from NELS:88 data, such as 'Family Income' and 'Parental Involvement,' are added to the regression model. Existing research reports that parents' involvement impacts mathematical achievement, whether directly, as in homework, or indirectly, as in setting up and monitoring homework time, particularly in elementary and middle

school settings (Hong & Ho, 2005; Swinton et al., 2009). A study on Black high school students found that students whose parents attended school meetings earned higher math achievement scores (Strayhorn, 2010).

Model 3 will examine the impact of school-level variables. In the NELS:88 data, this category includes variables such as ‘Percent Minority in School,’ and ‘Students Incapable of Learning Material.’ How does the addition of school-level variables impact the overall regression model?

4.4.1 Individual-level variables. Controlling for all the other variables in Model 1, Model 2, and Model 3, for every unit increase in ‘Respondent’s Educational Aspirations,’ the ‘Mathematics Standardized Test Score in 1992’ increased by 1.52, 1.07, and 1.13 units, respectively. The relationship in Model 1 was statistically significant at the .01 level, and statistically significant at the .05 level for Model 2 and Model 3.

Controlling for all the other variables in Model 1, Model 2, and Model 3, for every unit increase in ‘Grades from 6th-until 8th-Grade,’ the ‘Mathematics Standardized Test Score in 1992’ increased by 2.31, 2.32, and 2.30 units respectively. The relationship is robust and statistically significant at the .001 level in all three models.

Controlling for all the other variables in Model 1, Model 2, and Model 3, for every unit increase in ‘Amount of Coursework Taken in Geometry (in years),’ the ‘Mathematics Standardized Test Score in 1992’ increased by 3.88, 3.85, and 3.96 units respectively. The relationship is robust and statistically significant at the .001 level in all three models.

Controlling for all the other variables in Model 1, Model 2, and Model 3, for every unit increase in ‘Amount of Coursework Taken in Algebra II (in years),’ the ‘Mathematics

Standardized Test Score in 1992' increased by 4.93, 4.40, and 4.37 units respectively. The relationship is robust and statistically significant at the .001 level in all three models.

Controlling for all the other variables in Model 1, Model 2, and Model 3, for every unit increase in 'Time Spent on Extracurricular Activities,' the 'Mathematics Standardized Test Score in 1992' increased by 0.86, 0.77, and 0.67 units respectively. In Model 1, the relationship was statistically significant at the .01 level and statistically significant at the .05 level for Model 2 and Model 3.

Controlling for all the other variables in Model 1, Model 2, and Model 3, Black female students who were held back scored 5.28, 4.47, and 4.86 points less, respectively, on the 'Mathematics Standardized Test Score in 1992' than did Black females who were not held back a grade. The relationship was robust and significant at the .01 level for all three models.

Controlling for all the other variables in Model 1, for every unit increase in 'Part of Friends Who Plan to Attend a Two-Year Community College or Technical School,' the 'Mathematics Standardized Test Score in 1992' decreased by 0.96, revealing a statistically significant relationship at the .05 level. Although the relationship continued to be negative for Model 2 and Model 3, it was not significant.

Controlling for all the other variables in Model 1, for every unit increase in 'Part of Friends Who Plan to Attend a Four-Year College or University,' the 'Mathematics Standardized Test Score in 1992' increased by 0.99; that relationship was statistically significant at the .1 level. The relationship continued to be positive for Model 2 and Model 3, but it was not significant.

The Adjusted R^2 for Model 1 was .503, indicating that approximately 50.3% of the variation in the outcome variable, 'Mathematics Standardized Score in 1992,' is accounted for by these student-level predictors. The F-test was statistically significant at the .001, confirming that

these variables are useful in predicting the outcome variable.

4.4.2 Familial-level variables. When the familial-level variables are added to the regression equation, controlling for all the other variables in Model 2 and Model 3, for every unit increase in 'Family Income,' the 'Mathematics Standardized Test Scores in 1992' increased by 0.53 and 0.51 units respectively; that relationship was statistically significant at the .01 level for both models.

Controlling for all the other variables in Model 2 and Model 3, for every unit increase in 'Parental Involvement,' the 'Mathematics Standardized Test Scores in 1992' increased by 0.72 and 0.78 units respectively, a relationship that was statistically significant at the .1 level in Model 2, and statistically significant at the .05 level in Model 3.

The Adjusted R^2 for Model 2 was .539, indicating that approximately 53.9% of the variation in the outcome variable is accounted for by the combination of these student-level and family-level variables. The F-test was statistically significant at the .001 level, confirming that these predictors are useful in predicting the outcome variable, 'Mathematics Standardized Score in 1992.'

4.4.3 School-level variables. Model three incorporates school-level, thereby combining individual-level, familial-level and school-level variables into the regression equation. 'Private School' bore no statistical significance. However, controlling for all the other variables in this model, for every unit increase in 'Percent Minority in School,' the 'Mathematics Standardized Test Scores in 1992' decreased by .53; that relationship was statistically significant at the 0.1 level. Controlling for all the other variables in this model, for every unit increase in 'Students Incapable of Learning Material,' the 'Mathematics Standardized Test Scores in 1992' decreased by .54; that relationship was statistically significant at the .1 level.

The Adjusted R^2 for Model 3 was .550, indicating that approximately 55% of the variation in the outcome variable, 'Mathematics Standardized Score in 1992,' is accounted for by these student-level, familial-level, and school-level variables. The F-test was statistically significant at the .001 level, confirming that these predictors are useful in predicting the outcome variable. The successive increase of the Adjusted R^2 due to the addition of independent variables in each model, indicates that there is no collinearity amongst the independent variables. In other words, the independent variables are not correlated.

Table 4. 4
Unstandardized Regression Coefficients (Beta in parentheses) for Mathematics Standardized Score in 1992 (N = 194)^a

	Model 1	Model 2	Model 3
<i>Individual-level Variables</i>			
Respondent's Educational Aspirations	1.52** (.18)	1.07* (.13)	1.13* (.14)
Math Grades from 6 th - until 8 th -Grade	2.31*** (.24)	2.32*** (.24)	2.30*** (.24)
Amount of Coursework Taken in Geometry (in years)	3.88*** (.23)	3.85*** (.22)	3.96*** (.23)
Amount of Coursework Taken in Algebra II (in years)	4.93*** (.24)	4.40*** (.21)	4.37*** (.21)
Time Spent on Extracurricular Activities	0.86** (.15)	0.77* (.13)	0.67* (.11)
Respondent Has Been Held Back	-5.28** (-.17)	-4.47** (-.15)	-4.86** (-.16)
Part of Friends Who Plan to Attend a Two-Year Community College or Technical School	-0.96* (-.11)	-0.73 (-.09)	-0.70 (-.08)
Part of Friends Who Plan to Attend a Four-Year College or University	0.99 [†] (.10)	0.60 (.06)	0.57 (.06)
<i>Familial-level Variables</i>			
Family Income	---	0.53** (.17)	0.51** (.16)
Parental Involvement	---	0.72 [†] (.10)	0.78* (.11)
<i>School-level Variables</i>			
Private School	---	---	-0.75 (-.03)
Percent Minority in School	---	---	-0.53 [†] (-.09)
Students Incapable of Learning Material	---	---	-0.54 [†] (-.09)
Constant	24.87***	22.55***	26.32***
Adjusted R ²	.503	.539	.550
F	25.41***	23.53***	19.14***

^a Information above is based on a list wise deletion of cases.

[†] p < .1

* p < .05

** p < .01

*** p < .001

One of the goals of this dissertation is to examine the multivariate influence that selected individual-level, familial-level, and school-level variables have on Black females' enrollment in postsecondary mathematics courses (PSE).

Table 4.5 presents Comparison of Means on 'Respondent Took Math Class(es) During PSE' by Independent Variables. Comparison of means examines whether the mean scores of two independent variables are statistically significant from each other for respondents who took credit bearing math classes in postsecondary institutions. The six independent variables were: 'Amount of Coursework Taken in Geometry (in years),' 'Mathematics Standardized Score in 1992,' 'Family Income,' 'Parental Involvement,' 'Percent Minority in School,' and 'Students Incapable of Learning Material.' The scores of respondents on the 'Mathematics Standardized Score in 1992' were significant at the .01 level. This indicates that, on average, Black females who had higher scores on the 'Mathematics Standardized Score in 1992' were more likely to take a regular math class in a postsecondary institution. 'Amount of Coursework Taken in Geometry (in years)' proved to have a positive statistically significant impact at the .05 level. This indicates that, on average, Black females who took more coursework in geometry were more likely to take a regular math class in a postsecondary institution.

Table 4. 5
Comparison of Means on Respondent Took Math Class/es during PSE by Independent Variables

Independent Variables	Respondent Took Math Class/es During PSE	
	No	Yes
Amount of Coursework Taken in Geometry (in years)	0.55* (89)	0.68 (201)
Mathematics Standardized Score in 1992	47.01** (76)	50.26 (338)
Family Income	7.36 (89)	7.91 (199)
Parental Involvement	2.34 (80)	2.41 (169)
Percent Minority in School	4.96 (100)	4.97 (216)
Students Incapable of Learning Material	1.89 (85)	1.99 (182)

* p = .05 ** p = .01

Note: The superscript of the level of statistical significance is placed just on one of the two categories of the dependent variable to indicate that the mean scores of such two categories are statistically significant from each other. Conversely, the absence of a superscript on any of the two categories of the dependent variable indicates that they do not differ from each other at any of the levels of statistical significance considered.

Table 4.6 presents cross tabulations of the two categorical independent variables, 'Respondent Has Been Held Back' and 'Private School,' by the dependent categorical variable 'Respondent Took Math Classe(es) during PSE.' The Chi-Squared test of the variable, 'Respondent Has Been Held Back,' by the dependent dichotomous variable 'Respondent Took Math Classe(es) during PSE,' returned a value close to zero, indicating that the null hypothesis is not rejected (statistical independence). In other words, whether a Black female had been held back a grade had no relationship with whether she enrolled in a credit bearing (regular) math course in a postsecondary institution.

Similarly, the Chi-Squared test of 'Private School' by the dependent dichotomous variable, 'Respondent Took Math Classe(es) during PSE,' indicated that there is no relationship between a Black female attending a private school and whether she enrolled in a credit bearing math course (regular) in a postsecondary institution.

Table 4. 6
Cross Tabulations of Independent Variables by Respondent Took Math Class(es) during PSE

<i>Independent Variables</i>	Respondent Took Math Class(es) during PSE (row percentages, n_{ij} in parentheses)		Total
	No	Yes	
<i>Respondent Has Been Held Back</i>			
No	33.2% (90)	66.8% (181)	100.0% (271)
Yes	33.3% (7)	66.7% (14)	100.0% (21)
Total	33.2% (97)	66.7% (195)	100.0% (292)
χ^2 (<i>p-value</i>)		0.00 (.991)	
<i>Private School</i>			
No	31.0% (81)	69.0% (180)	100.0% (261)
Yes	34.5% (19)	65.5% (36)	100.0% (21)
Total	31.6% (100)	68.4% (216)	100.0% (316)
χ^2 (<i>p-value</i>)		0.26 (.611)	

Table 4.7 presents Logistic Regression Coefficients (Odds Ratio in parentheses) Predicting Respondent Took Math Class(es) During PSE (N = 147)^a. The four models, Model I, Model II, Model III, and Model IV in Table 4.7 show logistic regression coefficients predicting enrollment in a regular math class, versus not enrolling in a regular math course, across individual-level, familial-level, and school-level variables. Odds ratios greater than one suggest that there is a positive association between an independent variable and categorical variable.

In Model I, for every one unit increase in ‘Amount of Coursework Taken in Geometry (in years),’ the likelihood of a Black female enrolling in a credit bearing math course in a postsecondary institution increased by a factor of 2.05; this relationship is statistically significant at the .05 level. ‘Respondent Has Been Held Back’ shows a negative relationship that is not statistically significant.

In Model II, Model III, and Model IV, for every one unit increase in ‘Mathematics Standardized Score in 1992,’ the chances of a Black female enrolling in a credit bearing math course in a postsecondary institution is increased by a factor of 1.06, 1.07, and 1.07 respectively. This relationship is statistically significant at the .05 level. None of the other variables exhibit statistical significance.

Table 4. 7
Logistic Regression Coefficients (Odds Ratio in parentheses) Predicting Respondent Took Math Class(es) During PSE (N = 147)^a

	Model I	Model II	Model III	Model IV
<i>Individual-level Variables</i>				
Amount of Coursework Taken in Geometry (in years)	0.72* (2.05)	0.41 (1.51)	0.44 (1.56)	0.48 (1.62)
Respondent Has Been Held Back	-0.04 (0.96)	0.18 (1.19)	0.23 (1.26)	0.22 (1.25)
Mathematics Standardized Score in 1992	---	0.06* (1.06)	0.07* (1.07)	0.07* (1.07)
<i>Familial-level Variables</i>				
Family Income	---	---	0.03 (1.03)	0.02 (1.02)
Parental Involvement	---	---	-0.18 (0.84)	-0.22 (0.81)
<i>School-level Variables</i>				
Private School	---	---	---	0.14 (1.15)
Percent Minority in School	---	---	---	-0.11 (0.89)
Students Incapable of Learning Material	---	---	---	0.12 (1.13)
Constant	0.17 (1.19)	-2.56* (0.08)	-2.73 [†] (0.07)	-2.49 [†] (0.08)
χ^2 (df)	4.32 (2)	10.39* (3)	11.65* (5)	13.35 [†] (8)
-2 Log likelihood	185.47	179.40	178.13	176.43
Nagelkerke R ²	.04	.09	.11	.12

^a Information above is based on a list wise deletion of cases.

[†] p < .1

* p < .05

** p < .01

*** p < .001

Chapter Five: Discussion

5.1 Introduction

This dissertation employed ordinary least squares (OLS) and multiple regression analyses to examine individual-level, familial-level, and school-level variables that impact Black females' proficiency in high school mathematics, as well as predict their enrollment in regular postsecondary mathematics courses.

This chapter is an analysis of the results presented in Chapter Four. Based on sociological theories, existing literature, and reasonable conjecture, this dissertation contextualizes its findings within a framework that is conducive to examining Black females' experiences with high school mathematics.

When controlling for '*Mathematics Standardized Score in 1992*,' (score on the twelfth grade mathematics exam), variables from all three levels affected Black females' achievement in high school mathematics. The score on the twelfth grade math exam was significant in predicting the likelihood that a Black female enrolled in a regular mathematics course in a postsecondary institution.

The traditional practice in educational research is to use the metric of socioeconomic status (SES) as a proxy for class. SES is an economic and sociological combined total measure of a person's work experience and family's economic and social position based on income, education, and occupation. In order to fully examine Black females' attainment in high school mathematics, SES information is incorporated in this discussion.

5.1.1 Individual-level variables. This study found that Black female students' educational aspirations had a positive impact on their proficiency in high school mathematics. This supports research relating students' educational aspirations to educational achievement

(Astone & McLanahan, 1991; Yan & Lin, 2005). Students with aspirations to attend a four-year college tended to score higher on mathematics achievement tests than those students with aspirations to attend less than a four-year college (Hanson, 1994). On average, Black females in this study planned to attend a four year-college.

According to Astone and McLanahan, "...high aspirations are a critical factor predicting educational achievement" (1991, p. 310). The fact that the twelfth grade mathematics examination was taken in the spring semester of their senior year provides strong evidence that the young women in this study graduated from high school. Therefore, Black female students' educational aspirations may also contribute to their success in high school degree attainment.

In a study of 30 Black youth, Hubbard (1999) found that girls aspired to go to college for the academic credentials that would enhance their career prospects. The positive effect of educational aspirations may reflect a young Black woman's embrace of American rhetoric regarding the importance of education for future success, as well as the belief that her academic efforts will be rewarded in the labor market. Black females' educational aspirations may also represent the educational environments in which they learn. These environments are a result of the more than 30 years of nationwide efforts under the Patsy Mink Equal Opportunity in Education Act of 1972 (Title IX) to end sex discrimination in school programs and activities in order to bring about gender equity in schools and society at large.

Although this study did not investigate the relationship between the educational aspirations parents have for their daughters and their daughters' educational aspirations, it seems reasonable to conjecture that students' educational aspirations are influenced by their parents' educational aspirations. Using 6-year longitudinal data from NELS:88, Trusty (2000) found that parents' aspirations influenced their teenagers' academic self-efficacy, which, in turn, affected

the teenagers' long-term educational attainment. However, his findings were not conclusive when examining racial and ethnic differences. Yan and Lin (2005) found that regardless of racial or ethnic background, parents' educational aspirations for their children had a strong positive effect on twelfth-graders' mathematics achievement.

Studies have shown that prior academic achievement in mathematics is a strong correlate of subsequent achievement in math for Black high school students (Adams & Singh, 1998). Using data from NELS:88 to study the academic achievement of Black students in tenth grade, Adams and Singh, controlling for SES and gender, found that prior achievement had a strong effect on subsequent achievement. In the present study, the grades that Black female students received in mathematics from sixth until eighth grade was one of the strongest predictors of achievement on the twelfth grade mathematics exam and the relationship remained statistically robust across all regression models. Prior success in mathematics promotes future success in mathematics and the results from this study support extant literature.

The positive effect of prior achievement in mathematics on Black females' proficiency in twelfth grade mathematics suggests that patterns of high achievement—and, conversely, low achievement—are determined prior to high school. This finding also sheds light on the need to develop education that builds positive mathematical identities for all children, regardless of their race, ethnicity, gender, or socioeconomic status. A major policy implication of this finding is that educational interventions and outreach should be extended to Black female students early, perhaps in primary school, in order to affect outcomes in high school and beyond.

The amount of coursework taken in Algebra II and the amount of coursework taken in Geometry were also strong predictors of Black females' achievement in high school mathematics. This finding supports research that found that the challenges of rigorous course-

taking are related to high school success and proficiency in mathematics. Burkam and Lee (2003) found that course-taking was strongly related to twelfth grade mathematics achievement and proficiency. In addition, course-taking had a substantial effect on gains in proficiency from eighth to twelfth grade. In many states, Algebra II and Geometry are considered advanced-level mathematics courses, since they are beyond the minimum mathematics requirements for high school graduation. Black females who took Algebra II and Geometry had developed stronger mathematics skills, and this was reflected in their scores on the twelfth grade mathematics exam.

College admission, access to course-taking in college, and eligibility for majors are often determined by the mathematics courses taken in high school (Adelman, 1999). Advanced mathematics course-taking in high school, particularly those above the critical threshold of Algebra II, is a strong determinant of college attendance and subsequent degree completion (Schneider, 2003). The present study found that a Black female who took geometry in high school was twice as likely to take a regular mathematics class in a postsecondary institution. This finding supports extant literature. However, in the full logistic model, the score on the twelfth grade mathematics exam was the only variable of significance that predicted the likelihood of a Black female taking a regular course in a postsecondary institution. This supports literature that reports high school mathematics scores as one of the most powerful predictors of postsecondary educational attainment (Tyson et al., 2008).

Findings from the present study help to solidify the widely acknowledged gatekeeper role that mathematics plays in gaining access to postsecondary education. The importance of grades and test scores suggests these measures provide Black females with the confidence to succeed in high school and the motivation to pursue a college education.

Grade retention (being held back a grade) had a negative effect on Black females' scores on the twelfth grade mathematics exam. This finding supports the literature on the adverse effects of grade-level retention on achievement in mathematics. A meta-analysis of studies related to the effects of grade-level retention on elementary and junior high school pupils revealed the negative effects on mathematics achievement and other educational outcomes (Holmes & Matthews, 1984; Reynolds, 1992).

While being held back a grade was an event that took place prior to entering high school, its influence can have long-term developmental effects, as evidenced by the scores on the twelfth grade mathematics exam. Students who are held back are separated from their peer group and may have been reassigned to classes with younger, less academically advanced students. While some educators may contend that grade retention is another intervention aimed at remediation, students may experience this event as an indictment of their mathematical capabilities.

Interestingly, being held back a grade had no relationship with whether a Black female enrolled in a regular mathematics course in a postsecondary institution. The variability in grade retention did not contribute significantly to the explanation of the variance in enrolling in a regular mathematics class when controlling for other variables. Another explanation for the lack of relationship could be that, once students arrive at high school, the stigma of being held back has been forgotten or perhaps the remediation was successful. The negative effect of grade retention on scores on the twelfth grade mathematics exam, and the lack of relationship on enrollment in postsecondary mathematics courses, may be a result of the different sample sizes. Not all of the students who took the twelfth grade mathematics exam subsequently registered for a mathematics course in a postsecondary institution that was not vocational, technical, or trade.

In 2010, Reynolds used data from the Chicago Longitudinal Study (CLS) to investigate whether grade retention was associated with participation in postsecondary education. The study sample included 1,367 participants using data for grade retention and educational attainment by age 24. Findings indicated that grade retention was associated significantly with lower rates of participation in postsecondary education. Findings from the present study do not support this conclusion. The different findings may be due to the different measures of postsecondary attendance. Reynolds examined participation in postsecondary education, whereas the present study only examined Black females' who took the twelfth grade mathematics exam, and who subsequently registered for a mathematics course in a postsecondary institution that was not vocational, technical, or trade. A larger sample size in the present study may have resulted in results that were more significant.

Prior research (Broh, 2002) has shown that students who participate in extra-curricular activities have higher grades than those who do not. This study supports this research. The amount of time Black females spent on school-related extracurricular activities had a positive impact on their score on the twelfth grade mathematics exam.

There was an inverse relationship between the portion of friends who planned to attend a two-year community college and Black females' scores on the twelfth grade mathematics, albeit only slightly significant. There was a positive relationship, approaching significance, between the portion of friends who plan to attend a four-year college or university and Black females' scores on the twelfth grade mathematics exam. The directions of the relationships were not surprising, but the levels of statistical significance were.

The academic requirements to attend a two-year college may not be as high as the requirements to attend a four-year college. Therefore, having a high proportion of peers who

only plan to attend a two-year college may negatively impact Black females' motivation and lead to lower scores on their twelfth grade mathematics exam. Similarly, having a high proportion of peers who plan to attend a four-year college may raise Black females' motivation and result in higher scores on the twelfth grade mathematics exam. It seems reasonable to expect that the academic aspirations of Black females' peers would have a significant influence on their achievement in mathematics. The literature on peer influence reports that students who have friends with plans to attend college are more likely to have a strong predisposition for college attendance (Carpenter & Western, 1982; Falsey & Heyns, 1984). The findings from this study do not support the literature. The educational aspirations of Black females' peers did not significantly impact their proficiency in high school mathematics. Perhaps a larger sample size would have led to a conclusion supportive of extant literature.

5.1.2 Familial-level variables. Family income exhibited a positive relationship with Black females' scores on the twelfth grade mathematics exam. Adams and Singh (1998) concluded that SES had a statistically significant effect on achievement in mathematics for Black high school students. It is not surprising that family income, one of the composite variables of SES, impacted Black females' achievement in high school mathematics. However, family income was not statistically significant in predicting a Black female's likelihood of taking a regular mathematics course in a postsecondary institution. Family income is a familial-level variable that predicts Black females' proficiency in high school mathematics, but does not predict the likelihood of enrollment in a regular mathematics course in a postsecondary institution.

Students' educational aspirations had a significant impact on Black females' proficiency in high school mathematics. However, when controlling for parents' income, students'

educational aspirations were less significant in predicting a Black female's proficiency in high school mathematics. Hanson (1994), using the 1986 High School and Beyond (HSB) data, found that males and individuals from upper socioeconomic status backgrounds were more likely to have high educational expectations and score higher on standardized tests in mathematics. This study found that, on average, Black females aspired to attend college, regardless of their socioeconomic status. That parents' economic capital proved to be a strong predictor of proficiency in high school mathematics and also reduced the statistical significance of educational aspirations on the twelfth grade mathematics score may be explained by the benefits of economic capital.

Parents with higher levels of economic capital can acquire important physical capital (books and computers) and provide additional academic activities such as preparation courses to enrich their daughters' mathematical education. Economic capital also affords parents the possibility of living in neighborhoods that have high quality public schools or of sending their daughters to private schools.

The time spent on school related extracurricular activities had a positive impact on Black females' achievement in high school mathematics. However, when controlling for parents' income, extracurricular activities showed a less significant impact on the twelfth grade mathematics exam. This result can also be explained by parents' economic capital.

Parents with more economic capital may be able to provide extracurricular activities that take place outside of the school environment. These activities may be related to mathematics, such as mathematics enrichment or tutoring. Other activities unrelated to mathematics, such as trips to museums and sports events, also increase students' embodied cultural capital and motivate learning.

On average, the family income of respondents in this study was between \$10,000 and \$19,999. Although this data was taken in 1992, it still remains representative of the Black experience in America. Data from the 2007 census reports that 5.7 million Blacks lived in households with an income of \$19,999 or less annually. While, as reported by the latest census, the percent of Black families below the poverty rate has decreased from 33.4 percent in 1992 to 26.0 percent in 2010, judged against household incomes for White Americans, these figures are still dispiriting (U.S. Census Bureau, 2010). Based on these incomes, parental capital may be a more accurate factor impacting Black females' achievement in twelfth grade mathematics.

Parental capital refers to parents' economic, human, cultural, and social capital. These four forms of capital are interrelated. In this study, economic capital appears to be the most prominent form of capital. However, Bourdieu (1986) posits that human, cultural, and social capital cannot be reduced to purely economic terms. Each form of capital allows parents to utilize resources for their children beyond what their economic capital would suggest. An example would be a parent with a low income who is able to cultivate his or her child's disposition towards college by enrolling their child in a free academic enrichment program, or having discussions related to academic matters. These non-economic benefits may be derived from parents' educational or work experiences, or from the information shared within a network of parents and teachers. These non-economic benefits illustrate forms of human, social, and cultural capital.

Parental involvement exhibited a positive relationship with scores on the twelfth grade mathematics exam; the relationship was approaching statistical significance. In the full regression model, parental involvement was a statistically significant predictor of Black females' scores on the twelfth grade mathematics exam. Adams and Singh (1988), controlling for an

extensive array of intervening variables, found that parental involvement did not have a significant effect on the mathematics achievement of Black high school students in tenth grade. However, these findings are counter to the results of a study by Strayhorn (2010), which found that parental involvement was a significant predictor of mathematics achievement for Black high school students in tenth grade. The conflicting results may be due to the definition used for parental involvement.

In this study, parental involvement was measured by how often parents attended a school meeting, spoke to a teacher or counselor, visited their daughter's class, or attended a school event. These measures reflected parents' direct involvement with activities that took place at the school. Parental involvement as defined by this study had a statistically significant impact on the mathematics achievement of Black female high school students. On average, Black female respondents indicated that their parents participated in two of the four activities.

This study found that, on average, parental involvement was not significant in predicting whether a Black female enrolled in a regular mathematics class in a postsecondary institution. Since parental involvement revolved around activities that parents participated in at their daughters' high schools, it is not surprising that parental involvement did not impact enrollment in a credit-bearing mathematics course in a postsecondary institution.

When controlling for the familial-level variables, family income and parental involvement, both peer-related variables were no longer statistically significant predictors of Black females' proficiency in high school mathematics. This may illustrate that Black parents exert a stronger influence on their daughters' education than that of their daughters' peers.

5.1.3 School-level variables. All three school-level variables that were used in the regression equations exhibited a negative relationship with achievement on the twelfth grade

mathematics exam; the relationships were not statistically significant. None of the school-level variables were significant in predicting the likelihood of Black females enrolling in a regular mathematics class in a postsecondary institution. The school-level variables were private school, percent majority, and teachers' perceptions of students' abilities.

In the bivariate analysis, Black females who attended private school, on average, did better on the twelfth grade mathematics exam. However, controlling for all individual-level variables, attending private school was not a significant predictor of Black females' achievement on the twelfth grade mathematics exam. Since only 12 percent of the Black females actually attended private school, the seemingly conflicting results could be attributable to the small sample size.

There was no relationship between whether a Black female attended a private school and whether she enrolled in a regular mathematics course at a postsecondary institution, and the logistic regression analysis confirmed this finding. So, overall, the findings from this study do not support the existing literature on the merits of private school as evidenced in the Coleman Report (1981) and recent research by Attewell and Lavin (2009).

In 2009, Attewell and Lavin used data from the City University of New York (CUNY) survey and National Longitudinal Survey of Youth (NLSY) to assess the merits of private schools. They found that children who attended private schools had better educational outcomes from elementary school through college than otherwise equivalent children who did not attend private school. On average, children who were sent to private school also showed bigger improvements in reading and mathematics. These differences were statistically significant after controlling for such family characteristics as race, class, and mother's IQ (Attewell & Lavin, 2009).

Research reveals that youth attending schools with a higher share of minority students tend to have lower levels of academic achievement as measured by scores on standardized tests (Linn & Welner, 2007). On average, Black female respondents attended schools that were between 41% and 90% minority. Some scholars have shown that Black students, especially those attending low-resourced and racially segregated schools, are afforded limited opportunities to learn (OTLs) (Jencks & Phillips, 1998; Tate, 1995). Teachers in schools with high percentages of Black and Hispanic students are less likely to be fully credentialed and are more likely to be teaching out of their fields of expertise, particularly in mathematics, than teachers in predominately White schools (Darling-Hammond, 2001). In addition, students attending majority minority schools may face other negative social conditions including unwelcoming learning environments and the presumption by many teachers and administrators that Black females are neither interested in, nor intellectually capable of, grasping mathematics. Therefore, to the extent that school segregation exposes minority students to less qualified teachers who expect less from them (Flores, 2007), their achievement is likely to suffer.

As expected, the percent of minority in school exhibited an inverse relationship with Black female high school students' mathematical achievement and likelihood of enrolling in a regular mathematics course in a postsecondary institution; the relationships were not statistically significant. The lack of significance may be caused by the smaller than ideal sample size or selection bias.

Research has linked teacher expectations for student performance with mathematics outcomes (Turner, Meyer, Midgley, & Patrick, 2003; Tyler & Boelter, 2008). In this study, teachers' expectations were measured by the teachers' responses to 'Students Incapable of Learning Material.' On average, teachers perceptions were between 'disagreed' and 'somewhat

disagreed' with the statement. Teachers' expectations were not statistically significant in predicting Black females' achievement in twelfth grade mathematics, or in predicting whether they would enroll in a regular mathematics course in a postsecondary institution. This finding does not support extant literature. One explanation for this study's conflicting finding may be that the variable used does not directly measure teachers' expectations of mathematical achievement of each Black female in the sample. Instead, it measures the expectations a teacher has for the students in the school, not only in mathematics, but in other subjects as well.

One noteworthy observation is that, when controlling for school-level variables, parental involvement in school activities become a statistically significant predictor of Black females' scores on the twelfth grade mathematics exam. It may be that the parents' involvement in the schools demonstrates their involvement in their daughters' lives, and impacts the positive results on the twelfth grade mathematics exam.

That none of the three school-level variables were significant predictors of students' achievement in twelfth grade mathematics supports one of the main findings of the 1966 report *Equality of Education Opportunity* (Coleman Report), which concluded that academic achievement was less related to the quality of a student's school and more related to the student's family background (Coleman, 1968). The present study shows that Black female students' academic achievement in mathematics is significantly related to familial-level variables.

Using only Black Non-Hispanic females creates a homogenous population that may explain the lack of school effect. Since students are located (nested) within a particular school, it would be reasonable to assume that a student's educational performance is impacted by that particular school (school effect). Hierarchical linear models (HLM) can be used to examine how each level influences the outcome variable, including the proper handling of data dependencies

created by the nested structure. One possible HLM model for the present study would have each Black female student's score on the twelfth grade math exam as a level-one variable, and the school attended as the level-two variable. However, HLM would be helpful in analyzing the school effect because of the lack of variability created by the homogenous nature of the sample. Therefore, the use of a monolithic sample could explain why the school-level variables were not statistically significant.

Another approach this present study could have used to examine the impact of school-level variables on respondents' mathematics achievement would have been to enter the school-level variables earlier in the linear regression analyses. The individual-level and familial-level variables accounted for 53.9% of variance before the school-level variables were even added to the regression analysis. Controlling for school-level variables only explained 1.1% of the variance.

One important contribution of this study is the embedding of the relationships between individual-level, familial-level, and school-level variables in a theoretical framework that emphasizes the roles that these often intersecting systems of influence play in determining proficiency in high school mathematics. Returning to the sociocultural framework that was presented in Chapter Two, the constructs of social, cultural, economic, and human capital are useful for understanding the benefits that accrue to individuals from different cultural contexts.

5.2 The Sociology of Education

In his 1988 paper entitled *Social Capital in the Creation of Human Capital*, Coleman shows how social capital in the family and community impact human capital formation. Human capital (Becker, 1964) consists of an individual's talents, skills, and knowledge that can be

converted into high levels of educational attainment and occupational status. In his study, Coleman used students graduating from high school as a measure of human capital formation.

In this study, human capital formation is measured by a student's score on the twelfth grade mathematics exam and whether they enrolled in a credit bearing mathematics course in a college or university. Students enter high school with a certain aptitude in mathematics (human capital) gleaned from their previous years of study, here measured by the mathematics grades earned in the sixth through eighth grades. As a student progresses through high school, they encounter opportunities to increase their human capital. Mathematics courses taken in Algebra II and Geometry, and their participation in extracurricular activities, increased their human capital. Being held back a grade negatively impacted students' formation of human capital. Surprisingly, Black female students' social capital, as measured by the academic aspirations of their peers, failed to be statistically significant predictors in their quest to acquire more human capital.

The social and cultural capital of the family (parental involvement), as well as the family's economic capital (income), proved to be significant predictors of a Black female student's formation of human capital.

The school also presents a source of social capital. The three measures: private school, percent majority, and teachers' perceptions of students' abilities, were not significant predictors of Black females formation of human capital.

5.3 Summary

It is a common practice in educational research to examine differences among racial groups to discuss disparities in achievement. This dissertation focused on the nature and extent of Black females' attainment in high school mathematics.

This study set out to answer the question: How do individual-level, familial-level, and school-level variables impact Black females' proficiency in high school mathematics, as well as predict their enrollment in postsecondary mathematics courses?

Respondents' prior achievement in mathematics was measured by the grades they received in mathematics from sixth until eighth grades. Prior mathematics achievement was the most significant predictor of achievement in high school mathematics, as measured by scores on the twelfth grade mathematics exam. The scores on the twelfth grade high school mathematics exam were the most powerful predictor of Black females' likelihood of enrolling in a credit bearing mathematics course in a postsecondary institutions. Taken together, the major finding of this present study is that what happens prior to attendance in high school is more significant than what happens in high school, and even predicts mathematics course taking in postsecondary institutions. Therefore, attention to mathematics achievement prior to high school would be the best recommendation to increase Black girls achievement in high school mathematics and subsequent enrollment in regular mathematics courses in postsecondary institutions.

There has been a clear preoccupation among researchers to use White male students as the standard to which all others are measured. Existing literature examines the mathematical achievement of females and minorities as if all females are White and all Blacks are men. In order to examine the Black achievement gap in mathematics in its complexity, many researchers have advocated for research that explores the gender heterogeneity (Adams & Singh, 1998; Campbell, 1986; Crumb & Grodsky, 2010; Lim, 2008; Martin, 2009; McGraw et al., 2006; Signer et al., 1997; Strayhorn, 2010; Tate, 2004; Yan & Lin, 2005). By examining the intersection of race and gender, this study clearly responds to the call.

Chapter Six: Implications, Recommendations and Future Research

6.1 Introduction

The aim of this dissertation was to determine individual-level, familial-level, and school-level variables that impact Black female students' proficiency in high school mathematics, as well as predict their enrollment in postsecondary mathematics courses.

Data employed in the present study were drawn from the National Education Longitudinal Study of 1988 (NELS) conducted by the National Center for Education Statistics (NCES). NELS is a nationally representative panel study that followed a cohort of American eighth-graders for twelve years as they progressed through high school on to employment or postsecondary education.

Ordinary least squares (OLS) and multiple regression analyses were employed to determine which independent variables had the greatest impact on Black female respondents' achievement in high school mathematics.

This study found that the individual-level variables that significantly impacted Black females' proficiency in high school mathematics were: educational aspirations, prior academic achievement in mathematics, advanced mathematics course-taking, extra-curricular activities, and grade retention. The educational aspirations of Black females' peers were not significant predictors of their proficiency in high school mathematics. The familial-level variables, parental income and parental involvement, were also predictors of Black females' achievement in mathematics. The school-level variables, private school, percent majority, and teachers' perceptions of students' abilities were not significant in predicting Black females' proficiency in high school mathematics.

The score on the twelfth grade high school mathematics exam was the most powerful predictor of Black females' likelihood of enrolling in a credit bearing mathematics course in a postsecondary institution.

6.2 Limitations

This study is hampered by a number of limitations. One set of limitations is related to the selection criteria of the sample. This study focused on the mathematics achievement of Black Non-Hispanic female students in twelfth grade. By limiting the sample to only one race and one gender, findings from this study cannot be used to make inferences about Black males or Whites, Hispanics, and Native Americans of either sex. Another limitation is the lack of ethnic identification within the Black race. By not examining the ethnic heterogeneity, factors that impact Black Americans' mathematics attainment may not be salient factors that impact the mathematical attainment for Blacks from the Caribbean, Africa, or Latin America.

The selection of this monolithic sample hampers the determination of whether it is gender or race that impacts the mathematics achievement of Black females.

Research shows the gender advantage of females over males in high school and bachelor degree attainment. Catsambis (1994) used data from NELS to explore the process by which women's participation in mathematics began to drop during adolescence. Catsambis found that the chances of White females enrolling in high-ability mathematics courses such as Algebra I, Algebra II, and Geometry by the tenth grade were higher than White males by about 25 percent. However, she also concluded that regardless of racial-ethnic group, female students tended to have less interest in mathematics, less confidence in mathematics and less interest in mathematics and science related careers. Gender stereotypes may explain White females' lack of interest in mathematics. Is it gender or racial stereotypes that explain Black females' lack of

participation in engineering and science careers? In addition to the racial and gender stereotypes, how does the SES of Black female students, usually lower than the SES of White female students, impact Black female students' achievement in mathematics? Crenshaw highlighted how the concept of intersectionality needs to be applied to examine interlocking systems of oppression that operate on the social structural level of institutions.

The 2006 study by McGraw et al. is an example that illustrates the importance of applying intersectionality. Using the results from the National Assessment of Educational Progress (NAEP), 1990-2003, to analyze gender gaps in math achievement, McGraw observed gender gaps favoring males occurred within White and Hispanic students, but gender gaps favoring males were non-existent for Black students. In fact, the gender gap favored Black females, especially within the content stands of fourth and eighth grade geometry and fourth grade data analysis.

Another limitation of this study is that it did not examine the impact of the composite variable SES on the mathematics achievement of Black female respondents. It is a common practice in educational research to use SES to explain the disparities in mathematics achievement. Although some researchers contend that SES is not always the best metric to use when studying educational attainment, specifically because it avoids the discussion of poverty and its effects on educational achievement, SES remains the standard metric for class (Secada, 1992; Tate, 2004).

This study used parental involvement as a measure of a family's social and cultural capital and family income as a measure of a family's economic capital. Therefore, some findings from the present study may not be comparable with extant literature. Since SES incorporates all three forms of capital; economic, social and cultural, the inclusion of SES with

parental involvement, with family income, or with both, would have resulted in a high correlation between two or more of the predictor variables in the regression analyses, multicollinearity. Multicollinearity would not have reduced the predictive power of the model, but, without a statistical remedy, valid results for any individual predictor—for example, SES—could not have been obtained. Possible remedies to allow the inclusion of SES would be to omit one, or both, of the variables measuring income and parental involvement, or to create a new composite variable. Mean centering may eliminate multicollinearity for predictor variables such as parental involvement which has a limited range (0 to 4) (Agresti & Findlay, 2009).

The selection of high school students presents another limitation of this study. Extant literature, including findings from this study, shows that prior academic achievement in mathematics is a strong predictor of future academic achievement in mathematics, suggesting the need to examine students in elementary school. Would students' mathematics achievement in elementary school be a significant predictor of achievement in high school mathematics? This study could not address this question.

A major limitation of this dissertation is its completely quantitative approach. The dissertation describes how the variables impact the mathematics proficiency of Black females but, absent a qualitative analysis, it cannot explain why they have the impact they do. For example, the educational aspirations of Black female respondents' peers were not significant predictors of their scores on the twelfth grade mathematics exam. A focus group with some of these young women would reveal what their relationships with their peers are like, and perhaps explain the lack of significance.

The small sample size presents another limitation. While the intersection of race and gender was useful in examining the within group differences, the creation of subgroups within

subgroups diminished the sample size of this study. The small sample size may result in a lack of statistical representation of a phenomenon being observed. For example, a larger sample may have given statistical significance to the impact of attending private school on mathematics achievement.

There are several limitations associated with using NELS:88. Although NELS:88 remains one of the most comprehensive databases used in educational research, it is more than 20 years old. Approximately 24,599 students were interviewed in the base year 1988, with most of those students re-interviewed in another four rounds of data collection in the years 1990, 1992, 1994, and 2000. NELS:88 also contains surveys from students' teachers, parents, and school administrators. In addition, the restricted database contains the coursework and grades from students' high school and postsecondary transcripts. Given the preponderance of data that could have been examined, the selection of the small number of variables used in this study presents another limitation.

The family life of the Black females in this study was not examined. Did they live in a female-head household? Were they married? Employed? Did they have children? These questions point to further limitations of this study. If a student has other responsibilities in addition to her schoolwork, she may not be able to participate in extracurricular activities or take a class such as Algebra II that may not be required for graduation, thereby impacting her score on the twelfth grade mathematics exam.

This study did not consider classroom, school, district, or federal policies. The input of elected officials was not ascertained, evidencing further limitations of this study. Some mathematics classes may stress problem-solving, whereas others may stress rote-memorization. The mathematics requirements for graduation may differ between schools, schools districts, and

states. Local politicians may allocate additional funds to run after-school mathematics programs. How would these policies impact the scores on the twelfth grade mathematics exam?

All limitations notwithstanding, much has been learned about Black female students and variables that impact their achievement in high school mathematics and their subsequent enrollment in regular mathematics classes in postsecondary institutions.

6.3 Implications

In January of 2012, The College Board Advocacy & Policy Center published a report entitled *The Educational Crisis Facing Young Men of Color*, documenting the educational challenges that the United States faces. It cautions that, if the current demographic and educational attainment trends continue, a larger proportion of the American population will be poorly educated. Current estimates suggest that the decline will be most noticeable in the year 2020, which is the same year that President Barack Obama set as a deadline for restoring the United States to being the first in the world in the percentage of young adults with postsecondary degrees. A major part of the challenge lies in erasing the disparities in educational attainment, so that low-income students and underrepresented minorities have the ability to complete degrees.

In this increasingly competitive world, those with the most education, and those with the skills that are most in demand, will be shrinking in numbers as a percentage of the population. Investing in the education of Black girls, especially in mathematics, seems like a prudent solution to the shrinking percentage of Americans who have the education and skills that are in most demand for the future. There is an African proverb that says, “If we educate a boy, we educate one person. If we educate a girl, we educate a family – and a whole nation.” By

educating a girl, she is likely to ensure that her children also receive an education, and hence the claim that investing in a girl's education is investing in a nation.

When controlling for the score on the twelfth grade mathematics exam, this study found that Black female respondents' educational aspirations, prior academic achievement in mathematics, advanced mathematics course-taking, extra-curricular activities, grade retention, and parental involvement significantly impacted Black females' proficiency in high school mathematics.

These findings have important implications for educational leaders, policy makers, and organizations. Although parents are thought of as the primary source of their child's educational aspirations, there are possible avenues for policy makers, school administrators, and teachers to participate in increasing students' educational aspirations. Programs that increase students' educational aspirations can be supported from the local level (such as schools and community groups) to the national level. Role models, mentors, and community leaders could help students realize the merits of high school achievement and future college attendance.

Policy makers should consider this study's theoretical ideas and empirical evidence demonstrating how the human capital that Black females' accrue prior to completing high school impacts their proficiency in high school mathematics. This knowledge will provide policy makers the impetus to create or modify existing programs to meet the educational needs of diverse student populations.

Since the measures of prior academic achievement and mathematics course-taking prove to be amongst the strongest indicators that affect Black females' proficiency in high school mathematics, policy makers should consider initiatives promoting less differentiation in the type of learning opportunities to which students of various social groups are exposed.

Researchers have consistently reported that, on average, Black students have not scored as high on national standardized tests of mathematics achievement as White students. Similarly, economically disadvantaged students have, on average, scored lower than economically advantaged students. Many Black students suffer from the poor mathematics outcomes that have impacted members of both groups of students. Although disparities in average test scores between groups of students have been often referred to as “achievement gaps,” these disparities in achievement scores are now recognized as “quality-of-service” gaps, reflecting the unequal access to opportunities to learn. An achievement gap defined by test scores is not a solvable problem, but unwelcoming learning environments and less skilled teachers are solvable problems. Programs that provide opportunities to learn advanced mathematics are initiatives that are likely to help students from public and low-SES high schools, because these institutions generally have few advanced placement courses or college preparatory programs.

The practice of grade retention, which disproportionately affects Black students, has important policy implications for curriculum development and teaching practices. Teachers should be made aware that grade retention as an intervention does not remediate achievement. Furthermore, the decision to retain a child is often based on factors unrelated to academic preparedness, such as whether the child is male, misbehaves, or attends urban metropolitan schools (Reynolds, 1992). Although some scholars have found that students who are held back a grade do better academically the second time they repeat the grade, there is evidence that demonstrates that grade retention has no long-term benefits. Schools should identify the areas in which poor performing students experience academic difficulties, and address these weaknesses through intensive enrichment programs.

This study showed that parental involvement is important for Black females' proficiency in high school mathematics. Extant literature has examined the virtues of parental involvement and culturally-relevant pedagogy as remedies for improving the achievement in mathematics for Black students. Perhaps what is also needed are culturally-sensitive approaches to parental involvement. Black parents' involvement in their child's schooling may not be similar to White parents' involvement, either in patterns of involvement or effectiveness (Yan & Lin, 2005).

Many educators and policy makers assume that Black parents' culture, values, and norms are oppositional to the culture, values, and norms of good schooling (Ladson-Billings, 1994). The view that low-income and working class Black parents are more of a deficit than an asset to their child's educational development has been accepted. However, educators have consistently emphasized the need for increased parental involvement from poor and working-class parents of color (Epstein, 1990; Fine, 1993).

The community-school relationship is a two-way process. Not only should the school be involved in bringing the parents to the school, but the school should be involved in how it can be a part of the community. The 2001 No Child Left Behind legislation (U.S. Department of Education, 2001) called on school leaders to increase the opportunities for parents to become more involved in the education of their children.

Because of the significant impact of parental involvement and course-taking patterns on achievement in mathematics, recommendations for improving outcomes in mathematics have often included more parental involvement and more opportunities to learn advanced mathematics. These recommendations seem sound and logical except that they do not give consideration to the possible constraints inherent in each. For example, parents have constraints

that are a consequence of the demands of work and lack of such resources as income and time. Schools have budget and structural (space) constraints that may not support the increase of advanced-level courses for the number of students who may need them. It may be that businesses, religious organizations, and institutions of higher education need to work with parents, local governments, and schools to mentor and provide services to enhance the educational opportunities for students. Organizations such as The Center for WorkLife Law at UC Hastings College of the Law (WorkLife) believe that many different parties have a role to play in social and organizational change around work and life issues, and work with employers to produce concrete changes. Options such as schedule control may allow parents more time to participate in activities at their child's school.

Walkerdine (1998) argues that women's underachievement and under-participation in mathematics play an important role in reproducing the gender inequality and gender stereotyping.

Intervention programs such as Go-Girl and "Voices" have been developed to improve Black girls' persistence in science, mathematics, and technology (SMT). The Go-Girl Programs have been undertaken in Philadelphia, Chicago, and Bloomington, Illinois. These programs targets poor middle-school girls of color and use collaboration between university and local communities to provide the cultural and social capital necessary to foster knowledge and career interest in mathematics and science careers (Brown, 2010)

"Voices" was a science and mathematics intervention program for middle school African American girls in rural and urban West Virginia. In the first year, girls met monthly for workshops. During the second and third years the girls worked with mentors who had careers in

science, mathematics, and technology, and they designed community service learning projects (Spatig et al., 1998).

6.4 Future Research

There are a number of other areas that could clarify or extend the results of the present study. One avenue for further research would entail addressing some of the limitations. To tease out race versus gender effects, the inclusion of White and minority women would need to be added to the sample. The inclusion of both sexes, in addition to ethnicity and SES, would lead to a more extensive examination of individual-level, familial-level, and school-level variables that impact the mathematics achievement of high school students.

Future research that examines the factors impacting mathematical achievement in elementary and middle schools could result in interventions that promote success in mathematics for high school students. Gender and racial disparities in mathematical achievement may actually be more prominent in high school as evidenced by scores on standardized tests such as SAT. Gender and racial stereotypes may be largely responsible. However, addressing learning disparities in elementary school could eliminate or mitigate them in middle and high school.

Although this study used longitudinal data, it is explanatory, and the relationships inferred are correlational. To further substantiate the results of this study, more evidenced based experimental or quasi-experimental studies could be conducted. The addition of a qualitative component would help explain the ‘why’ of relationships. Future research might also include data from other studies, as well as a survey instrument created specifically for this dissertation. By using a mixed–method approach, the examination of classroom, school, district, and federal policies would be possible. Qualitative studies using focus groups and surveys would allow for

the direct input from the many people who interact with students, such as peers, family members, and school administrators.

The National Longitudinal Survey (NLS) Series conducted by the United States Department of labor is comprised of six surveys. The National Longitudinal Survey of Youth 1997 (NLSY97), conducted by the U.S. Census Bureau, documents the transition from school to work for a nationally representative sample of approximately 9,000 students who were aged 12 to 16 as of December 31, 1996. The NLSY97 collects data on youths' family and community backgrounds to help researchers assess the impact of schooling and other environmental factors on these labor market entrants (U.S. Department of Labor, 1997). Since NLSY97 contains extensive data on respondent's relationships with parents, their contact with absent parents, as well as their marital and fertility histories, this dataset would allow for the examination of family composition variables, such as whether the household was headed by one parent, or was a female-headed household. This would allow for a deeper examination of parental involvement.

Future research that examines the persistent disparities in mathematics achievement, enrollment in advanced-level mathematics courses, and employment in science and engineering careers between White middle-class males and females could utilize more recent data from the NLS of Young Women, which was administered approximately every other year between 1968 and 2003.

Given the shortage of Black females in STEM fields, future researchers could estimate the effect of various individual-level, familial-level, and school-level variables on the scientific achievement of Black females in high school, and possibly protract this work into postsecondary contexts.

Future research might also examine various subsets. Do the same results hold steady for low socioeconomic Black females versus not-low socioeconomic Black females? Are there regional differences in the ways the variables impact Black females' achievement in high school mathematics?

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