A Counseling Program Intervention For Improving African American Students' Science, Technology, Engineering, and Mathematics Dual Enrollment Participation

by

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Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Education in

Curriculum and Instruction

College of Education

University of South Carolina

2018

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ACKNOWLEDGEMENTS

I cannot imagine persevering on this journey without the help of the Lord. Certainly, His blessings are paramount in all areas of my life and for this I am eternally grateful. I have also been blessed with a wonderful family. Thank you Chris and Christopher for your unwavering love and support; and to my parents, I appreciate you for planting the seeds of excellence in us all. Daddy, I miss you and wish you could have held on just a little while longer to share in this moment with me.

I could not have successfully completed this research study without many caring and encouraging professors within the University of South Carolina's College of Education. First, I am grateful to my dissertation chair Dr. Suha Tamim for her guidance, patience, and support at all critical stages of the research process. I am also appreciative of my dissertation committee, which included Dr. Yasha Becton, Dr. Rhonda Jeffries, and Dr. Christine Lotter, for the time and energy they invested to review my writing and to offer helpful feedback.

I must also thank Dr. Richard Lussier for helping me to organize my thoughts and to structure a research study that merged my passion for STEM with my desire to improve academic and social outcomes for African American students in South Carolina. Finally, I would like to express my gratitude to the Crosstown School District and its Middle and High School leadership teams for answering countless questions and for granting me access to their data, students, and community for the duration of this study.

ABSTRACT

African Americans are underrepresented at all points in the STEM pipeline from K-12 coursework into professional careers. The reasons for this underrepresentation are varied and reflect a myriad of contributing factors based on early academic experiences, sociocultural influences, and the effects of standardized testing. The three-fold purpose of this study was to implement a counseling program to inform nine African American study participants about the dual enrollment opportunity at their high school, to gain perspective about the factors which shaped their STEM disposition, and to determine the effect of the program on their attitudes about dual enrollment participation. The study employed qualitative methods to collect data from surveys, interviews, field notes, and observations. The data analysis was grounded in four theoretical constructs: Critical Race, Self-Efficacy, Sociocultural, and Culturally Relevant Pedagogy Theory. The study findings indicated that the participants' STEM disposition could be attributed to a broad range of factors, with some of the most significant of these being ineffective teachers, limited access to meaningful STEM learning experiences, narrowed curriculum options, and an inadequate supply of role models.

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LIST OF ABBREVIATIONS

AP .....Advanced Placement

CHS..... Crosstown High School

CSD..... Crosstown School District

ECP .....Early College Program

EOC..... End of Course

ESEA..... Elementary and Secondary Education Act

IGP .....Individual Graduation Plan

NCES .....National Center for Educational Statistics

PLTW..... Project Lead The Way

PSS.....Premier STEM School

STEM……Science, Technology, Engineering, and Mathematics

CHAPTER 1

INTRODUCTION

While addressing congregants attending a memorial service for Dr. Ronald E. McNair following the Space Shuttle Challenger disaster, Reverend Jesse Jackson painted a vivid portrait of McNair's rise from humble beginnings in segregated Lake City, South Carolina to become an accomplished laser physicist "chosen by God to defy the odds of oppression" (Cheers, 1986, p. 88). Despite Reverend's Jackson's declaration more than 30 years ago, Dr. McNair's victory over "the odds of oppression" remains an elusive goal for many African American students in South Carolina and throughout the United States, especially when considering who has access to and achieves in STEM fields (Brown et al., 2015; Lewis & Connell, 2005).

African Americans were credible contributors to the scientific community long before they gained legal access to educational opportunity and Dr. McNair ventured into space (Manning, 1998). Despite the efforts and successes of early pioneers and modern scientists, African Americans remain significantly underrepresented in science and related careers (Lewis & Connell, 2005; Summers & Hrabowski, 2006). This underrepresentation is reflected at all points in the science pipeline (Brown et al., 2015) and it is evidenced by significant gaps in K-12 STEM course enrollment, persistence, and achievement, as well as college degrees awarded between African American students and their White peers in the United States (Brown et al., 2015; Neuhauser, 2015; Lewis, 2003). This dilemma presents a problem worthy of further study.

Advanced placement (AP) courses are one pathway to STEM access for high school students who are "academically prepared and motivated to take on college level courses" (The College Board, 2014, p. 3). Among South Carolina's 2015-2016 student population, only 10.6 percent of AP tests were taken by African American students compared to 71.5 percent for White students (The College Board, 2016). When considering only tests administered in STEM fields, African Americans accounted for 8.7 percent of exams compared to 70.8 percent for Whites (The College Board, 2016). The racial disparity in AP STEM participation is only overshadowed by the achievement gaps it confirms. The aforementioned African American test takers had a mean passing score (3 or better, on a scale of 1–5) on only 1 of 10 STEM exams compared to 6 of 10 for White students (The College Board, 2016).

Standardized test results matter. They guide the curriculum agenda at the federal, state, and local levels, including what constitutes achievement, which courses will be offered, who will gain access to those courses, and the types and extent of resources allocated to support these curriculum choices (Pershey, 2011; Robinson, 2013). Standardized tests are also used to make school-level placement decisions and to inform educators' perceptions about a student's ability to handle advanced coursework in gifted or other accelerated programs, especially in mathematics and science (Campbell, 2012; Koba, 1996; Morgan, Farkas, Hillemeier, & Maczuga, 2016; Smith, Trygstad, & Banilower, 2016). Therefore, subpar performance on standardized testing or an unfavorable teacher recommendation in the early grades delimits African American students' access to the rigorous middle and high school courses and important learning experiences which best prepare them for STEM careers (Smith et al., 2016; Thompson &

Allen, 2012). Prior history of low achievement also shapes students' internal beliefs about their mathematics ability and their overall STEM interest (Blank, 2013; Lewis & Connell, 2005; McGee, 2015). Thus, African American students are less likely to exert effort toward subject matter which reinforces negative self-perceptions (Jacobson, 2013; Pershey, 2011).

The impact of testing and the racial achievement gaps they illuminate are a manifestation of "multiple culprits for inequitable education" (Settlage, Butler, Wenner, Smetana, & McCoach, 2015, p. 382). These culprits include poverty, imbalanced distribution of education resources, inconsistent learning environments, limited or insufficient curriculum, poor teacher quality, and ineffective school structure and leadership practices. Such factors serve only to further marginalize and oppress students as their opportunity to engage in rich learning experiences is greatly restricted (McLaughlin, 2014).

The implications of reduced opportunity for the next generation of scientists and the African American community are too important to ignore (Melguizo & Wolniak, 2012; Summers & Hrabowski, 2006). Employment inequalities are of particular concern as the Bureau of Labor Statistics reported the December 2016 African American jobless rate (7.8 percent) was nearly twice that of Whites (4.3 percent) nationally, while also proclaiming that STEM occupations have strong growth projections and a propensity to be higher-paying than other professions in the United States and abroad. Melguizo and Wolniak (2012) stated "the labor market rewards individuals trained in fields that receive more in depth training solving abstract problems and applying quantitative methods" (p. 401). For this reason, STEM achievement is a promising pathway for African Americans

to overcome the effects of racial oppression, which are at the heart the community's socioeconomic instability (Charleston, Charleston, & Jackson, 2014).

All students benefit from exposure to a rigorous curriculum (Cook, 2013). Many schools promote the AP program as an excellent option to experience college-level coursework while a student is still in high school. However, AP course credit is only granted if a student is able to succeed on the AP exam (Howley, Howley, Howley, & Duncan, 2013). Therefore many students, including African Americans, are unable to reap the college benefit from AP participation and end up demoralized by a disappointing test score after a full year of coursework (Hugo, 2001).

Dual enrollment programs are accelerated learning partnerships between school districts and area colleges that allow high school students to concurrently register for college courses (Hoffman, Vargas, & Santos, 2009). Students earn college credit by successfully completing all coursework (Hugo, 2001). Dual enrollment creates an opportunity for STEM interested students to preview college level coursework without the pressure of a must-pass examination; thus, they are a promising option to increase racial minorities' college preparation and access (Hugo, 2001).

Medvide and Blustein (2010) noted the imbalance in career development literature, with the greatest focus placed on urban racial minorities who are underexposed to advanced coursework and have no plans to pursue college. However, in order for students to learn about and prepare for postsecondary opportunities, they need guidance and support from a number of stakeholders, especially school counselors (Camizzi, Clark, & Goodman, 2009). This action research study examined the effectiveness of a counseling program designed to increase the number of African American students who

participate in STEM dual enrollment courses at Crosstown High School (CHS) (pseudonym). The study was structured by Sociocultural, Critical Race, Culturally Relevant Pedagogy, and Self-Efficacy Theory based on a review of the most current literature, which is addressed in Chapter 2.

Statement of the Problem

The identified Problem of Practice (PoP) for this action research study focused on low levels of participation in science and mathematics dual enrollment courses among African American students at Crosstown High School (CHS). The CHS Report Card confirmed modest dual enrollment participation and substandard STEM achievement (South Carolina Department of Education, 2016). Only 73 of the school's 813 students (approximately 9 percent) were taking advantage of dual enrollment courses and, 56 of the 73 (77 percent) were participating in a special STEM Early College Program (ECP) which required them to enroll in the dual enrollment classes.

The STEM ECP functions on the cohort model, with a new group of invited students added each academic year. Students who participate in the STEM ECP are invited to join the program as seventh graders. They complete coursework toward a high school diploma and an Associate of Science (A.S.) degree simultaneously. The program is currently in its sixth year. However, the STEM ECP attrition rates shown in Table 1.1 are concerning. Therefore, the CHS dual enrollment program may be unsustainable without increased participation among non-ECP students.

Through preliminary investigation the participant-researcher learned the Crosstown School District (CSD) administration eliminated advanced placement (AP) courses for all students in 2011. Consequently, CHS students, and in particular African

Americans, have been underexposed to the rigor of college-level coursework, especially in STEM, over the last six years.

Table 1.1

Enrollment Data for STEM ECP by Cohort

Cohort	Year Admitted	Current Grade Level	Initial Number of Admitted Students	Current Enrollment*	Attrition Rate (%)
1	2012	11	20	10	50
2	2013	10	24	20	17
3	2014	9	45	29	36
4	2015	8	32	23	28
5	2016	7	38	23	40

*As of January 18, 2017

The CSD is under new leadership since 2012. With this change, the school district has gradually increased curriculum rigor and improved course options by participating in Project Lead the Way (PLTW), reinstating some AP classes and establishing dual enrollment partnerships with a local technical college (South Carolina Department of Education, 2016). The original AP and dual enrollment classes restored and offered under this new administration have been in the humanities, and more STEM classes—both AP and dual enrollments—have been gradually added to CHS curriculum. The expanded STEM course options are directly linked to the new CSD leadership's decision to start the STEM ECP in 2012. The curriculum expansion was necessary to satisfy the A.S. degree requirements for ECP students. However, the CSD administration also viewed this decision as an opportunity to increase STEM participation and achievement among all

CHS students (CSD Superintendent, personal communication, February 10, 2016). Thus, the district opened participation in the dual enrollment courses without any costs to all interested students who meet the technical college's admissions requirements. In spite of this policy, participation in the STEM dual enrollment courses among non-ECP students has been relatively low (CSD Administrator, personal communication, February 23, 2017).

Significance of the Study

Crosstown High School (CHS) is located in a high-poverty, rural South Carolina county (South Carolina Department of Education, 2016). The December 2016 CSD county unemployment rate was 5.9 percent (SC Works, 2016), which placed the county's unemployment rate as the eighth highest of the state's 46 counties. Furthermore, the South Carolina Department of Employment and Workforce reported that from 2004 to 2014, the CSD county unemployment rate was consistently above both the state and national averages, reaching a maximum of 14.6 percent in 2010. Considering the county's historically high unemployment rate and Karanja and Austin's (2014) findings which connect the national employment forecast for African Americans to STEM job growth, CHS students stand to benefit from the potential increases with adequate STEM preparation. This study is important because it is a starting point for helping students to explore the possibilities of STEM, sustaining improved curriculum options at CHS, better preparing African American students for selective STEM college admissions policies which often disproportionately affect underrepresented students' chances to participate (Rogers-Chapman, 2014), and ultimately, increasing the students' opportunities for college success, career fulfillment, and economic stability.

For the past two decades, the education community has acknowledged that STEM achievement gaps exist, responded by conducting research to better understand the problem and used its findings to steer discussions about possible solutions (ACT, 2012; Wallace & Brand, 2012). As part of this dialogue, science frameworks have evolved with a greater emphasis on issues of diversity, equity, and social justice (Lee, Miller, & Januszyk, 2014). Consequently, the body of research into African American students' achievement, particularly in mathematics and science, and the most effective curriculum and instructional practices has grown significantly. Despite this progress, there remains significant gaps in the knowledge about the impact of culture and race on STEM teaching and learning (Howard, 2014; Jackson & Ash, 2012; Ladson-Billings, 1995; Milner & Laughter, 2015), the most effective methods for teaching science in underserved communities (McLaughlin, 2014; Norman, Ault, Bentz, & Meskimen, 2001), the relationship between school composition and racial achievement gaps (United States Department of Education, 2015), the causes and effects of early formation of achievement gaps (Curran & Kellogg, 2016; Ferguson, 2015; Morgan et al., 2016), and the types of data-driven, school-based interventions which may increase African American students participation in advanced STEM courses (Camizzi et al., 2009; Davis, Davis, & Mobley, 2013)

A review of the literature, which is more closely explored in Chapter 2, clearly establishes that STEM participation and achievement gaps exist (Blank, 2013; Curran & Kellogg, 2016; Koba, 1996; Morgan et al., 2016; Norman et al., 2001). The United States government has further declared that closing these gaps is a national priority (Neuhauser, 2015; United States Department of Education, 2015; The White House, 2015). However,

the exact causes of the problem and practical solutions remain a point of debate. Some researchers point to socioeconomic factors (Chapman & Donner, 2015; Ferguson, 2015), resource inequities (Brown et al., 2015; Smith et al., 2016), and policy decisions (Gross & Hill, 2016; Hartney & Flavin, 2014, Simms, 2012; Stuart Wells, 2014; T. Wright, 2011). Others purport that educators lack the skill, training, commitment, content knowledge, and cultural competence to effectively reach and teach African American students (Adamson, Santau, & Lee, 2013; Decuir-Gunby, 2009; Howard, 2014; Ladson-Billings, 2000; Milner & Laughter, 2015; Schmeichel, 2012; Wallace & Brand, 2012). Still more researchers emphasize the negative impact of high-stakes testing (Lomax, West, Harmon, Viator, & Madaus, 1995; Thompson & Allen, 2012) and the accountability movement (Rector-Aranda, 2016; Werts et al., 2013) on narrowed curriculum options which have hurt African American students' opportunity to become involved in significant learning experiences which build self-efficacy and sustain STEM interest, participation, and achievement over time.

This array of factors is addressed by Museus and other researchers (2011) through their Racial and Ethnic Minorities in STEM (REM STEM) model. This model unifies the differing perspectives of the leaky STEM pipeline and illustrates relationships among the many constructs believed to influence STEM participation and achievement. For instance, the REM STEM model explains how variables which comprise a student's K-12 experience, such as educational inequity, early STEM exposure, and culturally relevant curricula, directly influence outcomes such as academic preparation, course choices, and STEM disposition—which includes "self-efficacy, interest, and aspirations and expectations" (p. 89). Furthermore, the REM STEM model draws direct connections

between K-12 STEM opportunities and outcomes for underrepresented students, from high school into postsecondary studies and careers. Despite an ever growing body of research devoted to increasing STEM participation and achievement among African American K-12 students, the number of studies that focus on interventions which support dual enrollment as a means of improving STEM disposition for students in rural high schools is limited.

Rural students face many barriers to postsecondary ambitions and participation, including geographic isolation, poor quality teachers, limited access to rigorous classes, community cultures, which may devalue college attendance, and insufficient numbers of college-educated role models (Ferguson, 2015; Graham, 2009; Peters Burton et al., 2014; Peterson, Bornemann, Lydon, & West, 2015). Furthermore, when considering that rural students are often limited in their exposure to challenging math courses, their preparation for and likelihood of pursuing STEM careers is greatly reduced (Graham, 2009). Additionally, Cassidy (2015) called on researchers to expand the body of research dedicated to the actions—in terms of persistence and achievement—of students in challenging settings where self-efficacy and resistance to negative self-perceptions may be critical to their success. Thus, the findings of this study may potentially fill in gaps in the literature.

Purpose Statement

The primary purpose of this action research study was to implement a counseling program which informed African American students who are not a part of the STEM Early College Program (ECP), about dual enrollment opportunities at CHS. The secondary purpose was to determine if participating in the counseling program

encouraged students to consider pursuing dual enrollment STEM classes at CHS. Finally, the tertiary purpose of the study was for the participant-researcher to collect data amongst these African American students to ascertain information about their prior STEM experiences and their perceptions of the counseling program activities, and then to use that data to reflect with teachers, school counselors, administrators, and other stakeholders in order to institute a steady and durable dual enrollment program for African American students in the Crosstown School District (CSD). The research methodology is addressed more specifically in Chapter 3.

Research Questions

Through the present study, the participant-researcher sought answers to the following questions:

1. What is the effect of a counseling program intervention on African American students' STEM disposition at Crosstown High School?
2. To what extent does involvement in the counseling program influence these African American students' attitudes about math and science dual enrollment participation?
3. What are the most significant factors that shaped these African American students' STEM disposition?

Conceptual Framework

Hargrave (2015) presented the underrepresentation of African Americans in STEM from two vantage points, which are summarized by the following assertions:

1. African American students' participation in STEM is far less than their representative population in K-12 education.
2. African American students have underperformed in STEM, in terms of their measures of academic achievement—standardized test scores, grades earned, and attainment of related college degrees—compared to those of their White peers.

A review of the literature confirmed Hargrave's (2015) statements and linked them to a number of conceptual constructs which may explain African American students' minimal STEM participation and low levels of achievement. This action research study was grounded within four of these constructs which include Sociocultural, Self-Efficacy, Critical Race, and Culturally Relevant Pedagogy Theory.

Sociocultural Theory. Sociocultural theory, according to the early 20th century cognitive psychologist Lev Vygotsky, emphasized the significance of social interaction and culture on children's development. The impact of society and culture on how students develop higher-level mental functions is of particular importance, as these factors are directly linked to the choices humans make through their own will (Crowl, Kaminsky, & Podell, 1997).

Vygotsky (1987) believed children use inner speech, a form of self talk, to control their behavior. Through this type of internal communication, young people internalize challenges and talk themselves through the process of coping with and overcoming obstacles; so, a student who is struggling to solve a complex mathematics problem may engage in inner speech to construct an approach to solving it and arrive at the solution. Furthermore, Vygotsky emphasized the role that persons in positions of influence—teachers, school counselors, parents, and peers—play in students' cognitive development

and perceptions of socioculturally acceptable behaviors. Therefore educators are in a unique position to build students' self-concept, to address individual learning needs, to create culturally sensitive environments and curricula, and to engage students in meaningful learning which provides guidance and helps them to "internalize knowledge most efficiently" (Crowl et al., 1997, p. 73).

Teaching practices at CHS were not a direct focus of this action research study. However, educators' perceptions inform pedagogy and beliefs about a students' ability; and, these factors have been shown to influence curriculum and placement decisions as well as students' STEM disposition (Smith et al., 2016). Through the lens of Sociocultural Theory, this action research study may indirectly provide valuable insight into African American students' perceptions of the CHS teaching and learning culture and its effects on their course selection and STEM disposition.

Self-Efficacy Theory. CSD students have now been provided a platform to pursue STEM dual enrollment classes, yet many students have not taken advantage of the opportunity. When considering Alfred Bandura's (1977) Self-Efficacy Theory, students are unlikely to pursue subjects if they lack confidence in their ability to succeed. Furthermore persistence, especially in the face of adversity along the way, is directly linked to efficacy expectations. Students either expect to fail or to succeed; and, it is this belief that largely determines their attitudes, motivation, and ultimately their decision to either undertake the task or to avoid it. These efficacy expectations may be based on past personal experiences, others' experiences, receiving encouragement (or discouragement) from persons in positions of influence, and one's psychological or emotional state (Bandura, 1977). Thus, the researcher's anecdotally observed low levels of STEM self-