**Socio-Cognitive Motivation Predictors and STEM Persistence Plans
Among Women of Color:
A Social Cognitive Career Theory Reformulation and Investigation**

by

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DEDICATION

This work is dedicated to the family God has placed me in and has blessed me with.

To my grandmother, Marianne Morgan, who *taught* me who God is. It was through your faithful commitment to the Lord that I was introduced to His Sovereignty. It was you that I would see in the early hours of the morning, setting aside time for devotion and prayer, only to do it again at the end of the day. Your commitment to my spiritual growth, making sure I was in church, Sunday School, Bible Club, Vacation Bible School, and Young Adult Fellowship continues to be my guide in this life. Your commitment to my academic growth, late night science projects, using your weekends to get me back and forth to DAPCEP, and pushing me to attend UM as you saw something in me that I didn't quite see in it in myself at the time, I humbly and in gratitude say "Thank you!"

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ABSTRACT

This study reformulates social cognitive career theory by going beyond the conventional emphasis on self-efficacy to provide new insight into the multiple socio-cognitive motivation predictors of STEM persistence plans among Women of Color (African American and Latina). Building on expectancy-value and role-strain theories, a reformulated socio-cognitive career model (RSCCM) was developed to better understand pivotal motivational factors that empower some Women of Color, despite facing systemic barriers, to persist in their undergraduate STEM majors, pursue Ph.D. degrees and plan STEM research careers. This theory-driven study makes unique contributions to existing higher education literature on college persistence by further clarifying multiple socio-cognitive motivation predictors of STEM persistence plans among Women of Color during the undergraduate-to-graduate studies transition.

Based on a larger NIH-NIGMS funded study, multiple regression analyses were conducted on panel survey data from 179 Women of Color who applied to the Summer Research Opportunity Program (SROP) at 14 major universities affiliated with the Big Ten Academic Alliance (BTAA). Guided by the RSCCM, several hypotheses were tested to explore the role of STEM self-efficacy, STEM outcome expectancies, perceived STEM talents, STEM intervention-based appraisals, and perceived barriers and supports on STEM persistence plans. Findings indicate that in addition to self-efficacy, path-goal outcome expectations, strong faculty mentoring and perceived STEM talents were significant predictors of higher STEM persistence plans. Surprisingly, perceived discrimination was associated with higher rather than lower STEM persistence plans, and also moderated the relationship between self-efficacy and STEM persistence plans. The RSCCM and related study findings have important implications for theory, research and practice. First, RSCCM findings have theoretical significance for better understanding the multiple sources of motivation in STEM persistence decisions among Women of Color, especially during advanced stages of career development. Second, findings have important implications for future research to further clarify RSCCM propositions on larger and more diverse samples. Finally, RSCCM findings have policy relevance for informing strengths-based strategies that promote STEM persistence among Women of Color by reinforcing the multiple socio-cognitive motivational strengths that they bring to the BTAA-SROP and other pipeline intervention settings.

Chapter 1 Introduction

Choosing a career is one of the most significant decisions individuals make during their lifetime. While these decisions should be seemingly straightforward, for some individuals, career choices and persistence toward a career path are often thwarted by a complex set of factors. Status-related factors such as gender, race, ethnicity, and unwelcoming organizational contexts have been found to be especially problematic for women of all backgrounds and men of color pursuing careers in Science, Technology, Engineering, and Mathematics (STEM) fields (e.g., Hurtado, Newman, Tran, & Chang, 2010; Palmer, Maramba & Gasman, 2013; Stewart, Malley, & LaVaque-Manty, 2007). Regardless of race/ethnicity, women continue to be underrepresented in most STEM fields, especially at advanced levels and within the academic workforce (e.g., Stewart et al., 2007). Moreover, individuals of color are also grossly underrepresented in STEM fields, and face major barriers to STEM participation at every stage of the career development process — from the first year in college through post-graduate careers (e.g., Hurtado et al., 2010; Palmer et al., 2013).

Women of Color in STEM

This dissertation focuses on African American women and Hispanic American women who face a type of double jeopardy in their STEM career strivings due to the complex interaction of both race and gender barriers (Dowd, Malcom, & Bensimon, 2009; Hrabowski, Maton, Green, & Greif, 2002). While Asian American women — especially marginalized Asian American and Pacific Island subpopulations (e.g., Park & Teranishi, 2010; Teranishi, 2010) — also face discouraging gender barriers to successful STEM careers in comparison to their male counterparts, the unique historical circumstances of African Americans and Hispanic Americans in the United States present major STEM persistence challenges at each major transition point in the career development process —Pre-K-12, high school-to-college, undergraduate-to-graduate studies, and college-to-career transitions (e.g., Cole & Espinoza, 2008; Harper & Newman, 2016; Williams, 2014). Thus, a focus on the STEM career development process experiences among these two subpopulations of women is warranted.

In 2015, African American/Black women and Hispanic American women comprised 2% respectively, of employees in science and engineering occupations (National Science Foundation National Center for Science and Engineering Statistics [NSF-NCSES], 2017), but were 6.8% and 9.2% of the total U.S. population in the most recent U.S. Census (U.S. Census Bureau, 2011-2015 American Community Survey 5-year estimates). In comparison, White women comprised 20 percent of the science and engineering workforce, and White men, 51 percent (NSF-NCSES, 2017). Yet White women, — 39.6% of the U.S. population — were not *as* disproportionately underrepresented in science and engineering occupations as African American/Black and Hispanic American women, and White men (38.8% of the U.S. population) were significantly *overrepresented* among those in science and engineering careers. Such

STEM disparities are troubling since there are recent educational reform efforts, at both the secondary and postsecondary levels, focusing on multilevel policies, programs, and practices designed to increase the number of Women of Color in STEM fields (Borum & Walker, 2012; Nave, Frizell, Obiomon, Cui, Perkins, 2006). Despite these multilevel intervention efforts, Women of Color still face major challenges persisting toward STEM careers, especially during the undergraduate-to-graduate studies transition. For example, in 2010, of freshman enrollment in U.S. 4-year institutions, 32.3% of African American women and 36.1% of Hispanic American women indicated their intentions to major in a STEM field (NSF 2010, NSF, 2014). Yet, in 2014, only 12.9% of African American women and 10.25% of Hispanic women graduating from 4-year institutions were awarded STEM bachelor's degrees (NSF, 2010; NSF, 2014). These statistics highlight how Women of Color are not obtaining STEM undergraduate degrees as pathways to doctoral studies and research careers in STEM.

STEM Persistence Challenges: Theoretical Significance and Policy Relevance

This study of STEM persistence challenges facing Women of Color during the undergraduate years has important higher education policy relevance and theoretical significance. We need to better understand the pivotal factors that empower some Women of Color, despite challenges, to persist in their undergraduate STEM majors and pursue advanced graduate studies and research careers. More specifically, this dissertation has: (1) *theoretical significance* for addressing *major limitations and gaps* in existing college persistence research, especially during the undergraduate-to-graduate studies transition; and (2) *policy relevance* for informing more strengths-based STEM pipeline interventions that demonstrate particular efficacy for promoting STEM persistence among underrepresented groups.

Theoretical significance: Limitations of college persistence research. This dissertation study on STEM persistence challenges among Women of Color has important theoretical significance for filling critical gaps in existing literature on college persistence, STEM intervention efficacy, and social cognitive career theory. Despite some useful insights, the higher education literature on college persistence does not adequately explain factors that motivate STEM persistence among Women of Color at advanced stages of career development.

Much of the canonical research examining student persistence in higher education draws from college departure models (e.g., Astin, 1984, 1993; Bean, 1982, 1985; Berger & Milem, 1999; Cabrera, Nora, & Castaneda, 1993; Pascarella & Terenzini, 1991, 2005; Tinto, 1975, 1993). These college departure models conceptualize the decision to persist during the undergraduate years primarily as the outcome of a successful match between students and their institutional environments (St. John, Cabrera, Nora & Asker, 2000). This historical emphasis on student-institution fit limits the consideration of other factors that may help to explain differences in baccalaureate degree completion rates, especially by gender, race, ethnicity, and various contextual influences. Related empirical studies emphasize the adverse impact of racial/ethnic minority status, low parental socioeconomic status (SES), poor academic preparation, inadequate financial-aid, and lack of resources in both Pre-K-12 education and low-status minority-serving institutions (Corra, J. Carter, S. Carter, 2011; Soloranzo, Ceja, & Yossa, 2000; Soloranzo & Ornelas, 2002; St. John, Andrieu, Oescher, & Starkey, 1994; Torres, 2003).

Student-institution fit models of college persistence help to address why students depart *from an institution* during early stages of undergraduate studies, but there remains a serious gap in the higher education persistence literature on factors influencing departure *from an academic major*, discipline, or field of study (e.g., a switch from STEM to a non-STEM major), or intended career path, especially during the advanced undergraduate-to-graduate studies transition and beyond. Thus, this dissertation does not focus on why Women of Color are departing institutions at early stages of their undergraduate studies, but why some persist in STEM academic majors during the undergraduate-to-graduate studies transition and purse advanced doctoral studies and research careers. Additionally, while several higher education studies examine college student persistence in STEM (e.g., Chang, Eagan, Lin & Hurtado, 2011; Crisp, Nora, Taggart, 2009; Ong, Smith, & Ko, 2018; Perna et al., 2008, few investigate college student persistence from the lens of career development. In order to achieve a career goal, one has to persist in an academic major that will place him or her onto a pathway to ultimately get to one's desired career. Few studies seek to investigate multilevel social and psychological mechanisms that may better explain students' career choice, career development, and career commitment, which places them on a specific pathway toward academic persistence in a certain major or field of study.

Policy Relevance - STEM Pipeline Interventions and Student Persistence. Several National Academy of Sciences reports (NAS, 2005; 2007; 2010; 2011), emphasize the strategic importance of effective interventions for increasing STEM major and career persistence among racial/ethnic minority men, women of all racial/ethnic backgrounds, and other underrepresented (UR) students to promote the global competitiveness of the United States in the 21st century. To build a more robust STEM workforce, these reports note that greater gender and racial diversification requires effective interventions to promote persistence at critical stages across the higher education pipeline *(from Pre-K-12-to-college, from undergraduate-to-graduate, and advanced studies-to-professional/research careers)*. These reports have also spurred a growing policy-relevant focus by the National Institutes of Health (NIH), the National Science Foundation (NSF) and even the Department of Education on developing effective STEM pipeline interventions for UR students.

An increasing number of studies reveal that strengths-based pipeline interventions that go beyond the traditional narrow focus on either financial-aid *or* remediation of personal deficits are particularly effective at promoting STEM persistence (Bailey, 2015; Bowman, 2011; 2013; Hrabowski, 2015; Maton & Hrabowski, 2004; Ong, Wright, Espinosa, & Orfield, 2011; Stewart, Malley, & LaVaque-Manty, 2007; Williams, 2014). Strengths-based interventions provide a more comprehensive support system that leverages underrepresented students' personal strengths, varied perspectives, and cultural backgrounds, for a more multifaceted approach to scientific progress (Ong et al., 2011). An expanding collaboration among NIH, NSF, and other stakeholders has begun to provide additional insight into strengths-based factors associated with STEM pipeline intervention efficacy and differential benefits among subgroups of participants (e.g., Chubin, DePass, & Blockus, 2009; DePass & Chubin, 2008; Olson & Fagen, 2007).

Understanding Exemplary STEM Pipeline Interventions

As illustrated in Figure 1.1, recent evaluation studies have begun to highlight a few exemplary interventions with demonstrated effectiveness in promoting STEM success (Bowman, Forthcoming). These K-career STEM pipeline interventions have focused on mathematics excellence in K-12 schools (e.g., NSF-The Algebra Project), excelling in STEM undergraduate studies and pursuing doctoral degrees (NIH-National Institute of General Medical Sciences [NIGMS] Maximizing Access to Research Careers – Undergraduate Student Training in Academic Research [MARC U-STAR] and Research Initiative for Science Enhancement [RISE]), and advancement in STEM research careers (NSF-ADVANCE) among historically underrepresented racial/ethnic minority (URM) students and women of all groups — often against great odds. A series of strengths-based studies on the exemplary Meyerhoff Scholars Program at the University of Maryland, Baltimore County have further clarified the importance of three multilevel intervening mechanisms — strong *institutional* commitment, strong *program* support system, and strong student *personal* motivation — that help to better explain program efficacy (e.g., Hrabowski, 2015; Maton, Hrabowski, Ozdemir & Wimms, 2008; Maton, Pollard, Weise & Hrabowski, 2012).

The Present Study

The present study focuses on the Women of Color engaged with the ***Summer Research Opportunity Program*** (SROP), which is a collective of exemplary summer interventions at 14 major research universities designed to increase the number of UR undergraduate students who pursue Ph.D. studies and research careers. Designed with strengths-based principles, these exemplary interventions have demonstrated particular efficacy in increasing the number of URM PhDs in a range of STEM fields since 1986. Similar to other STEM pipeline programs for UR students that include structured research opportunities (e.g., RISE, MARC U-STAR), SROP interventions include especially high impact practices for diversifying the STEM academic workforce (Hurtado, Cabrera, Lin, Arellano, & Espinoza; 2009; Myers & Pavel, 2011). Despite evaluation studies supporting SROP program effectiveness (e.g., Davis, 2006; Foertsch, Alexander, & Penberthey, 2000), there is a growing interest in more **theory-driven studies** of such exemplary STEM pipeline interventions to better explain program efficacy. Rigorous outcome evaluation studies show clear *average benefits* for intervention participants over control groups — but *do not* explain *differential benefits* among UR students engaged in exemplary STEM interventions.

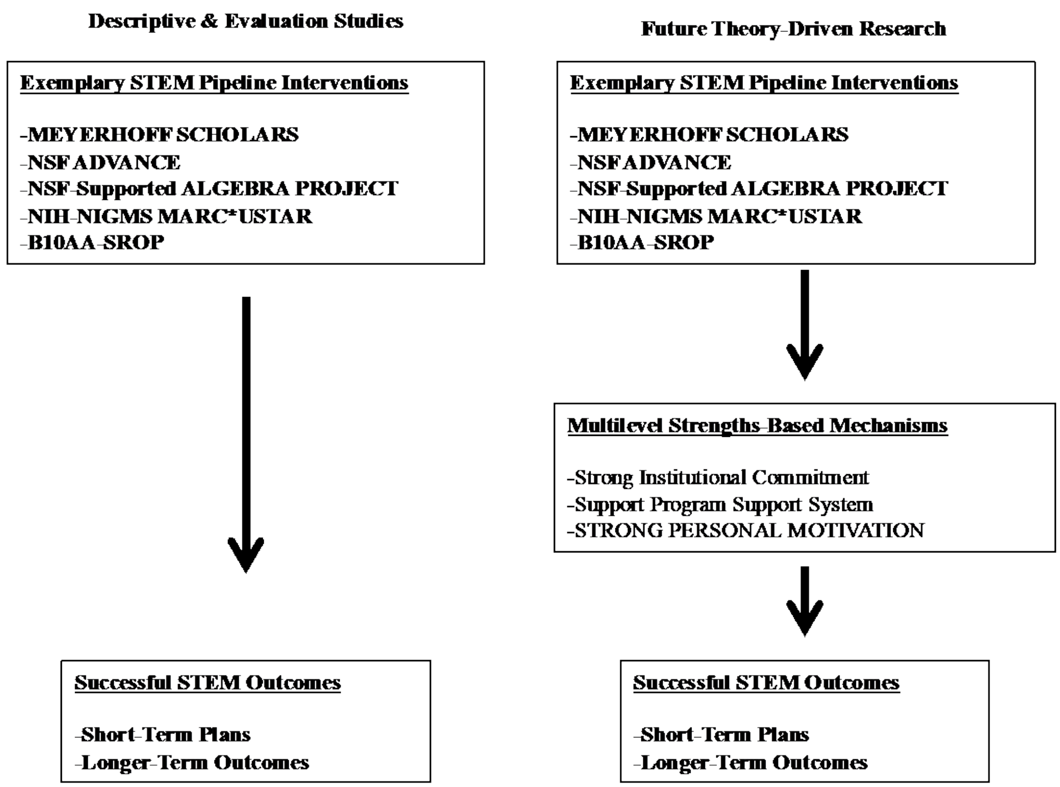

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Figure 1.1: Comprehensive Strengths-Based STEM Pipeline Interventions

Role of motivation in STEM pipeline interventions: Over the past two decades, NIH-NIGMS has developed an initiative to better understand exemplary pipeline interventions that have demonstrated particular efficacy in promoting scientific research careers among talented participants from UR groups. As suggested in Figure 1, this innovative NIH-NIGMS initiative seeks to fill a critical theoretical gap in evaluation studies documenting the efficacy of exemplary STEM pipeline interventions. Related strengths-based studies on various STEM pipeline programs further support the importance of three multilevel strengths-based intervening mechanisms — strong *institutional* commitment, strong *program* support system, and strong student *personal* motivation — to better understand intervention efficacy (e.g. Bailey, 2015; Bowman, 2011, 2013; Chubin, DePass, & Blockus, 2009; DePass & Chubin, 2008, 2015; Hrabowski, 2015; Maton & Hrabowski, 2004; Olson & Fagen, 2007). Related studies have provided unique insights into the role of both strong institutional commitment and a comprehensive multi-component support system (Bailey, 2015; Hrabowski, 2015). However, we still know much less about the role of personal motivation mechanisms in STEM pipeline intervention efficacy.

With a particular emphasis on undergraduate research opportunity programs, this NIH-NIGMS initiative seeks to identify and clarify key motivational mechanisms that help explain the efficacy of STEM exemplary interventions. More specifically, the present dissertation study is guided by ***three strengths-based motivational assumptions*** regarding the success of URM participants in STEM pipeline interventions (Bowman 2006, 2011, 2013). First, to be successful, URM undergraduates must be recruited with *both* strong academic backgrounds and strong motivation to pursue advanced Ph.D. studies and scientific research careers. Second, highly motivated URM undergraduate participants must be provided with *strong* intervention activities including state-of-the art scientific research opportunities with faculty mentors, appropriate facilities, and a multi-component support system. Third, such strengths-based pipeline intervention activities must *further strengthen* both students' research skills as well as their motivation to persist in STEM majors, to pursue advanced degrees, and to succeed in scientific research careers.

Understanding socio-cognitive motivation and STEM persistence plans. As highlighted in Figure 1.1, the present theory-driven study will: (1) build on evaluation studies that support the particular efficacy of strengths-based STEM pipeline interventions with URM students; and (2) seek to further clarify the role of socio-cognitive factors in motivating STEM persistence, especially among Women of Color within strengths-based STEM intervention settings. Building on prior evaluation research, this theory-driven study will systematically examine the role of motivation in STEM persistence plans among Women of Color STEM majors engaged in exemplary SROP interventions to systematically examine the role of motivation in STEM persistence plans. Furthermore, this theory-driven study on motivation in STEM persistence plans may also help illuminate differential benefits of strengths-based interventions among URM participants, with a particular focus on Women of Color.

Guided by ***social cognitive career theory*** (SCCT), a growing body of empirical research supports the importance of ***self-efficacy*** as a major source of motivation in career choice, persistence and success (Betz & Hackett, 1981; Gainor, 2006; Hackett, 1995; Hackett & Betz, 1981; Lent, 2005, Lent & Brown & Larkin, 1984; 1986; 1987). According to Bandura (1997), “perceived self-efficacy refers to beliefs in one’s capabilities to organize and execute the courses of action required to manage prospective situations. Efficacy influences how people think, feel, motivate themselves, and act.”(p. 2). Bandura’s work focused on self-efficacy expectations as the pivotal socio-cognitive motivational construct that both reflect interactions between individuals and their environments, and which impacts other socio-cognitive appraisals, learning, motivation and behaviors. Thus, the emphasis on the pivotal explanatory power of self-efficacy in SCCT builds on Bandura’s (1986) seminal social cognitive theory and related empirical research in psychology.

As illustrated in Figure 1.2, this dissertation goes beyond the narrow focus on self-efficacy beliefs within traditional SCCT for a more in-depth analysis of multiple socio-cognitive motivation predictors and STEM major and career persistence plans among Women of Color. Although traditional SCCT builds on basic propositions in ***expectancy-value theory*** (EVT) (Atkinson, 1957, 1966; Eccles, 1983, Eccles & Wigfield, 2002) — which includes the importance of one’s outcome expectations as a key motivational force — the narrow focus on self-efficacy fails to adequately consider theoretical and empirical evidence on other pivotal socio-cognitive motivation predictors (e.g. Bandura, 1982; 1986; Bowman, 1977; 2012; Eccles & Wigfield, 2002; Feather, 1982; Lawler, 1994). In addition to self-efficacy beliefs, psychological research framed by EVT also reveals how self-efficacy operates together with ***outcome expectancies*** and other ***socio-cognitive factors*** to better explain motivation and persistence (e.g., Eccles, 2009; Wang, Te, & Degol, 2013). Guided by these EVT psychological research insights, the SCCT reformulation in this dissertation goes beyond self-efficacy to also consider several other socio-cognitive motivation predictors including ***various outcome expectancies***, ***perceived natural talents***, and social-cognitive appraisals of ***intervention-based and previous learning experiences*** as well as more socio-cognitive appraisals of ***socio-cultural contextual barriers*** and ***supports***.

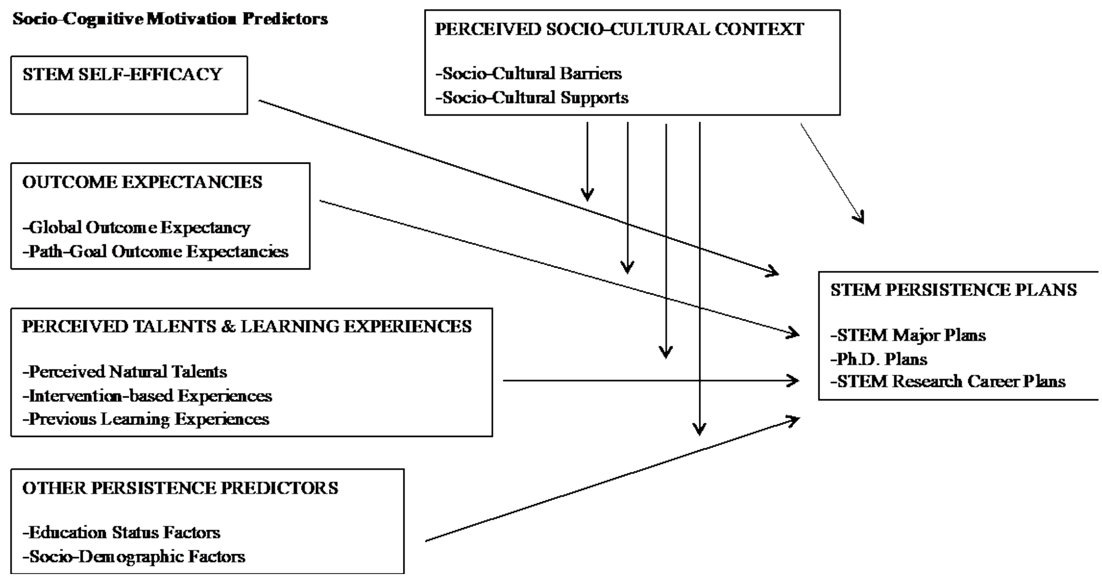


Figure 1.2. Multiple Socio-Cognitive Motivation Predictors and STEM Persistence Plans

Reformulation of social cognitive career theory: Beyond self-efficacy. Building on insights from EVT and a related role strain model, the major goals of this dissertation are to: (a) reformulate SCCT to better understand the pivotal role of self-efficacy and other socio-cognitive appraisals in STEM major and career persistence among UR students in pipeline intervention settings; and (b) employ this reformulated model to conduct a more in-depth investigation of socio-cognitive motivation predictors of STEM major and career persistence plans among Women of Color. In addition to self-efficacy, the SCCT reformulation builds on EVT to also provide deeper insight into the importance of other relevant socio-cognitive predictors to better explain STEM motivation, and major and career persistence among Women of Color (e.g. Bandura, 1982, 1986; Bowman, 1977, 2012; Eccles & Wigfield, 2002; Feather, 1982; Lawler, 1994).

My SCCT reformulation builds on a range of EVT models, but EVT models that focus on motivation in educational, organizational, and career development settings are especially relevant to understanding Women of Color's experiences in STEM interventions (Eccles & Wigfield, 2002; Hackett, 1995; Lawler, 1994; Mitchell, 1982). These EVT models and related empirical research further clarify how an individual's self-efficacy might operate together with their outcome expectancies, socio-cognitive appraisals of their STEM talents, and their STEM intervention-based experiences to motivate STEM major and career persistence plans. Building on principles from EVT, my SCCT reformulation also incorporates insights from a related role strain model to systematically consider how socio-cognitive appraisals of contextual barriers and supports might impact STEM persistence plans among Women of Color within pipeline interventions (e.g. Bowman, 2006; 2012; Burt, Williams, & Smith, 2018). Therefore, my SCCT reformulation goes beyond the traditional focus on self-efficacy to consider a range of socio-cognitive motivation predictors of STEM persistence plans among Women of Color who must often overcome systemic barriers associated with both race and gender.

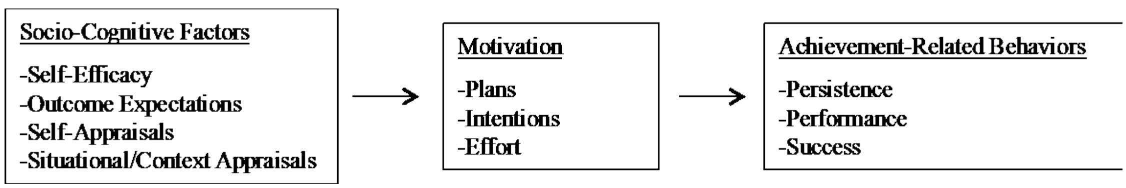


Figure 1.3. Role of STEM Persistence Plans in Longer-Term Persistence Outcomes

For a more meaningful analysis of STEM persistence, research on Women of Color within pipeline interventions should focus on both short-term STEM major persistence plans and longer-term STEM career persistence outcomes. As an EVT, the Theory of Planned Behavior (TPB) (e.g., Ajzen, 1988) and related empirical studies support the importance of short-term STEM persistence plans or intentions in predicting longer-term STEM persistence behaviors and outcomes (e.g., Ajzen, 1988; Fishbein & Ajzen, 1975). As illustrated in Figure 1.3, persistence plans are not only driven by socio-cognitive factors, but are also critical determinants of actual behavior (Ajzen, 1991; Cabrera et al., 1993; Doll & Ajzen, 1992; Foltz, L. Foltz, C. & Kirschmann 2015). By clarifying the pivotal effects of short-term intentions on longer-term behaviors, the TPB supports the importance of better understanding short-term persistence plans in persistence research within STEM pipeline interventions.

College retention theory and research in higher education also show the importance of persistence plans toward better understanding actual persistence outcomes. For example, empirical investigations of student attrition models (e.g., Bean & Metzner, 1985; Tinto, 1975, 1987, 1993) show that the "intent to persist" variable explained a significant portion of the variance in later persistence behaviors and outcomes (Chartrand, 1992; Sandier, 2000). Therefore, longer-term STEM persistence outcomes (e.g., faculty research career in STEM) among URM undergraduates within STEM interventions may be enhanced by strategies and mechanisms that reinforce *short-term plans* to persist in STEM majors, pursue advanced graduate studies in STEM, and pursue STEM research careers.

Major Research Propositions and Questions

The major goal of this dissertation is to *reformulate* SCCT and empirically investigate research questions that go beyond a narrow focus on self-efficacy to provide a deeper understanding of multiple socio-cognitive motivation predictors of STEM persistence plans among Women of Color during the undergraduate-to-graduate studies transition. The SCCT reformulation guiding this study helps to better clarify pivotal socio-cognitive motivational and contextual mechanisms within undergraduate STEM pipeline interventions that are designed to promote STEM major persistence, doctoral study and faculty research careers. More specifically, this dissertation reformulates SCCT propositions to investigate these critical STEM motivation and persistence issues among

Women of Color who are faced with systemic barriers associated with the complex intersection of both race and gender.

The SCCT reformulation provides the foundation for *five interrelated propositions* to guide future research on socio-cognitive motivation and STEM persistence plans among Women of Color at various stages in the higher education pipeline: (1) in addition to a student's self-efficacy, various outcome expectancies may be pivotal socio-cognitive motivation predictors of STEM persistence plans; (2) a student's perceptions of intervention-based experiences — social/verbal persuasion and vicarious learning — may reinforce self-efficacy and outcome expectancies and STEM persistence plans; (3) a student's self-appraisal that s/he has natural STEM talents may reinforce intrinsic outcome expectancies and STEM persistence plans; (4) a student's perceptions of the socio-cultural context — including barriers and supports — may also be significant socio-cognitive motivation predictors of STEM persistence plans; and (5) together with traditional predictors of college persistence (e.g., college GPA, socioeconomic status), multiple socio-cognitive motivation predictors help to further explain STEM persistence plans among Women of Color.

Based on existing socio-cognitive theory and empirical research, below I explicate my hypotheses for each research questions.

Q1) How do STEM-related socio-cognitive motivational predictors (self-efficacy and outcome expectations) predict STEM persistence plans among Women of Color?

Q2) How do STEM *intervention-based* experiences (mentor encouragement and vicarious peer learning) and *prior learning* experiences (academic mastery and emotional state) predict STEM-self-efficacy and outcome expectations among Women of Color?

Q3) How do intervention-based experiences, prior learning experiences, and socio-cognitive motivation factors collectively predict STEM persistence plans among Women of Color?

Q4) How do Women of Color's own perceived STEM talents predict their STEM self-efficacy, outcome expectations, and STEM persistence plans?

Q5) How do perceived socio-cultural context predictors (role-strain barriers and adaptive role supports) predict STEM persistence plans among Women of Color?

Q6) How do multiple socio-cognitive motivation predictors, together with traditional predictors of persistence, help to further explain STEM persistence plans for Women of Color.

Dissertation Outline

This dissertation is organized into six chapters. Following this introductory chapter, Chapter 2 provides a review of background literature on undergraduate persistence, undergraduate research programming, and the importance of better understanding the complexity of persistence challenges facing URM students pursuing STEM careers. Chapter 3 further clarifies the theoretical issues guiding this dissertation including an overview of the major constructs of the traditional SCCT, limitations of the narrow SCCT focus on self-efficacy for understanding STEM motivation and persistence among Women of Color, critical insights from expectancy-value models that guides my

SCCT reformulation, and a related conceptual model that guides the study's major research questions hypotheses. Chapter 4 describes the dissertation methodology including the research setting, the study's design and sample, operational definitions, and statistical procedures. Chapter 5 presents results from the statistical analyses to examine each of the research questions and related hypotheses. Finally, Chapter 6 provides a discussion of the major findings along with implications for both future research and practice.

Chapter 2 Background Literature

Despite their increasing levels of educational achievement, Women of Color continue to be occupationally segregated in the U.S. STEM labor force (NSF-NCSES, 2017). African American women and Hispanic American women currently comprise 2%, respectively, of this labor sector (NSF, 2017), although they were 6.8% and 9.2% of the total U.S. population in the most recent U.S. Census (U.S. Census Bureau, 2011-2015 American Community Survey 5-year estimates). Such underrepresentation is problematic because it suggests that Women of Color have differential opportunities to access a range of occupational choices within this field. In 2010, 35.3% of African American women and 38.1% of Hispanic American women expressed intentions to major in STEM while in their first year at a 4-year institution; only 10.2% and 12.9%, respectively, were awarded STEM bachelor degrees in 2014 (NSF, 2016). In the same year, the percentage of White women who received STEM degrees was 56% and 61% for White men, illustrating the relationship between gender and race/ethnicity in STEM fields (NSF, 2016). As statistics continuously show race/ethnicity and gender disparities in STEM degree attainment and employment, more theoretical and empirical research on the career choice, plans and career development of Women of Color is needed to understand why such educational and occupational gaps in STEM exist.

To study how STEM degree completion rates vary by race/ethnicity and gender, researchers have often used traditional college persistence models (Ceglie & Settlage, 2016). However, using these models to examine career persistence for Women of Color presents some limitations. While researchers using traditional models (e.g., Braxton, Vesper, & Hossler, 1995; Tierney, 1992) have demonstrated the effect of social and academic integration on persistence among college students of different socio-demographic backgrounds, other scholars examining persistence, especially among Women of Color, suggest that the intersection of race/ethnicity and gender brings about distinct experiences (e.g., Ong, Wright, Espinosa, & Orfield, 2011), that may present challenges to full integration into college life (e.g, Ceglie & Settlage, 2016, Hurtado & Carter, 1997). Women of Color have often perceived and/or experienced negative racial climates, both on campus broadly (Leath & Chavous, 2018; Lewis, Medenhall, Harwood & Browne, 2013) and specifically in their STEM majors (e.g., the classroom; Ong, Smith, & Ko, 2018; Ong, Wright, Espinosa, & Orfield, 2011). In particular, Women of Color in STEM report having their academic abilities questioned (McCoy, Winkle-Wagner, Luedke, 2015; McGee & Martin, 2011,) and biased attitudes from faculty and peers (Fries-Britt, Younger, Hall, 2010; Johnson, 2012, Ong, Smith, & Ko, 2018). While this research underscores many contributing factors influencing students' decisions to depart from STEM, many Women of Color find a way to navigate through these challenges (Carlone & Johnson, 2007; Espinosa, 2011; Ko, Kachchaf, Hodari, & Ong, 2014), which warrants further exploration. An alternative approach to examine Women of Color's decisions to persist is to understand the role that socio-cognitive motivation plays in their academic and career-related outcomes in STEM (Byars-Winston, Estrada, Howard, Davis & Zalapa, 2010). By investigating socio-cognitive motivation mechanisms that influence career choice, career development, and career commitment, we may better understand, and replicate in practice, the unique personal strengths, experiences and motivations that contribute to Women of Color's intentions to persist in STEM majors and ultimately, STEM careers (Espinosa, 2011).

This dissertation expands existing literature on Women of Color in STEM by using a socio-cognitive theoretical framework to understand how socio-cognitive motivation and socio-cultural contextual predictors influence successful outcomes in STEM. The purpose of this study is to reformulate social-cognitive career theory (SCCT) to address gaps in the existing literature to better explain pivotal motivation and contextual mechanisms that promote STEM persistence among Women of Color (Byars & Hackett, 1998; Byars-Winston, et al., 2010, Byars-Winston & Foaud, 2008). The focus on Women of Color in STEM majors, with an analysis of African American and Hispanic American women specifically, will provide unique insight into the complex intersection of race and gender in STEM education and career persistence. The focus on socio-cognitive motivation will provide a deeper understanding of how Women of Color arrive at decisions to choose STEM-related majors and continue to strive toward achievement milestones in STEM-related careers.

In this chapter, I begin with an overview of the higher education literature on the conceptualization of persistence and the current research on underrepresented minority college student persistence, with an emphasis on persistence in the STEM fields. This overview provides insight on the limitations of using traditional persistence models to study underrepresented minority student persistence in STEM majors and the limitations of such models toward understanding their advanced STEM career intentions. Next, I present the literature on undergraduate research programming and its influences on STEM persistence and advanced STEM career plans, especially for underrepresented minority students. I also introduce the undergraduate research program, Summer Research Opportunity Program (SROP), which is the research context for this study. Afterward, I close by presenting my case for the need for *theory-driven* studies of STEM persistence, particularly toward understanding STEM persistence among Women of Color. My case is presented through the lens of social-cognitive career theory.

Conceptualization of Persistence in Higher Education

College persistence research suggest that students' interactional experiences with their institution's system precedes their college departure decisions (e.g., Astin, 1984, 1993; Bean, 1982; Bean & Eaton, 2000; Bean & Metzner, 1985; Berger & Milem, 1999; Cabrera, Nora, & Castaneda, 1993; Pascarella & Terenzini, 1991, 2005; Tinto, 1975, 1993). In particular, scholars argue that the academic and social interactions students have within postsecondary institution systems have much to do with their decisions to remain in or depart from an institution (Tinto, 1993). Other scholars (e.g., Hagedorn, 2005) suggest that the same factors apply to students' decisions to depart from a major, discipline or field of study; the interactional and contextual effects of particular academic departments can also have an impact undergraduate students' decisions to persist. Whether from the college environment overall or from a particular academic unit, students' academic and social interactions and assessments of experiences feed into their self-beliefs about their capabilities to successfully perform in, and their future behaviors in a particular academic domain (e.g., continued persistence in a STEM academic major;

Bean & Eaton, 2000). The implication is that students' persistence decisions seem to be partly contingent upon their *perceptions* of their college experiences (Tinto, 1993).

As higher education research interrogates students' academic and social interactional experiences to examine college student persistence, there is an absence of research addressing students' psychological assessments of these experiences, including taking into consideration socio-cognitive motivation factors. Social cognitive career theory (SCCT) helps us to understand how students' cognitive assessments of their experiences, interests, and perceived and objective supports and barriers affect their decisions to persist. Students' cognitive assessments influence their self-beliefs in their capabilities to perform future similar academic tasks, as well as their expected valued outcomes in performing such tasks (Bandura, 1982). Before continuing with a review of the empirical literature on SCCT as it pertains to undergraduate persistence, the following section reviews and critiques the current higher education literature on undergraduate student persistence and URM undergraduate student persistence with a focus on URM undergraduate students in STEM.

Research Approaches to Undergraduate Student Persistence

Major theoretical models. Student-institution fit theoretical models have primarily guided a fair amount of the scholarship on undergraduate student persistence (Museus, 2007; Seidman, 2005). Higher education researchers employing student-institution fit theoretical models (Bean, 1980; Spady, 1970; 1971; Tinto 1987, 1993) primarily view college students' persistence decisions as the outcome of a successful match between the student's characteristics and experiences, and their institutional environments (St. John, Cabrera, Nora & Asker, 2000). Two models that have led this area of study are Tinto's (1975, 1993) model of student integration and Bean's (1980, 1982, 1983a, 1983b) model of student attrition (Braxton, Sullivan, & Johnson, 1997; Swail, 2003). Spady's (1970) sociological model of student departure informs these models. A review of these student-institution fit theoretical models will proceed in the historical order of their development.

Spady's theory of student departure. Spady (1970) provided the first methodical approach to understanding student departure by applying Durkheim's (1951) theory of suicide to college departure. Durkheim's (1951) theory claimed that suicide emerges when individuals are unable to become socially or intellectually integrated in the communities of a society (Tinto, 1993). Spady (1970) resolved that the same premise underlying the decision to withdraw from society (i.e., from life) also applies to the decision to withdraw from an academic community. He reasoned that if students are not able to integrate into the academic and social communities within the university environment based on their interactions with the influences, expectations, and demands imposed by various sources (Spady, 1970), they may decide to withdraw.

Tinto's theory of student integration. Building on Spady's (1970) work, Tinto's (1975) theory of student integration expounds on the longitudinal constructs of students' educational dispositions (intentions and commitments), interactions with institutional systems, and integration into the academic and social communities within the institution (Tinto, 1993). In his theory of student integration, Tinto (1975, 1993) postulated that, upon entry into the university, students' precollege attributes (e.g., personal characteristics, abilities, past performance, family background) predict their initial intention to persist to degree completion and commitment to complete the degree at that particular institution. After entry, students' interactional experiences with the academic and social systems within the institution then predict their integration into these systems; subsequent persistence decisions are a result of modified intentions and commitments from these interactional experiences. According to Tinto (1975, 1993), a student who does not achieve some level of academic or social integration is likely to depart the institution (i.e., not persist).

Tinto (1988) further developed his theory by applying social anthropology concepts from Van Gennep's (1960) work on the ritualistic "passage" of adolescents to full membership into adult societies. This movement as described by Van Gennep (1960) includes a three-phase process of separation, transition, and incorporation (Rendon et al., 2000). The presumption is that in order to fully integrate into a college or university, students must disassociate themselves from their precollege values, beliefs, and cultural backgrounds (Rendon, Jalomo, & Nora, 2000). In a revision to his early theoretical models, Tinto (1993) acknowledges the influences of students' connections to their external communities in regard to their persistence decisions. However, Tinto (1993) stresses that the impact of external influences on persistence is secondary to those of institutional influences (Tinto, 1993).

A strength of Tinto's (1993) theory is the importance of the college environment imparting relevant academic and social experiences to students and the central idea that students should be relatively engaged in aspects of the college community. However, using Tinto's model to examine URM undergraduate student persistence in STEM presents some limitations. One limitation is that Tinto's model (1975, 1988, 1993) is based on mainstream (e.g., White, middle-class, male) college student populations. Thus the model does not necessarily consider factors more relevant to the persistence process for individuals who are of different ethnic or racial-, gender-, or socioeconomic status, and/or other status-related characteristics. While there is evidence to support the notion that the academic and social integration constructs of Tinto's (1993) model are germane to all students (Braxton, Vesper, & Hossler, 1995), there is also research suggesting that these constructs may affect underrepresented students differently (Tierney, 1992), with varying outcomes, particularly for Women of Color (Carlone & Johnson, 2007; Espinosa, 2011; Seymour & Hewitt, 1997; Vogt, 2005; Wightman Brown, 2000).

Another limitation is that the model has an exclusive focus on student departure from an institution. Thus, factors influencing departure from an academic major, discipline, field of study (e.g., switching to a non-STEM major), or intended career path, in not within the scope of Tinto's model. Researchers have shown that students— particularly women, and especially Women of Color— who once had a strong interest in STEM later switch to non-STEM majors, indicating a lack of a sense of belonging (Rainey, Melissa, Mickelson, 2018), inadequate STEM career counseling and advising (M. Russell & J. Russell, 2015), and feeling that their broader STEM interest and goals were underemphasized and/or ignored (Falk, Rottinghaus, Casanova, Borgen, & Betz, 2017). A model to examine students' experiences in their initial intended major or field of study (i.e., an academic major in STEM), and particularly within the context of that intended major or field of study, would be useful to investigate specific factors that account for decisions to persist as it relates to their academic field.

A final limitation of Tinto's (1993) model is that its linear depiction implies that factors considered to impact persistence among first-year students may carry over to subsequent years (Nora, Barlow & Crisp, 2005). Nora and colleagues (2005) describe student persistence as a longitudinal process that varies in length and the factors that impact persistence may change in strength and/or direction over time. I would argue a similar process occurs within students' major, discipline, or field of study in respective academic departments**.** While college students may continue to reenroll in subsequent years, changing majors is still a consideration for many of them. This consideration is particularly important as students declare their majors (e.g., a specific field in engineering) and move towards more advanced courses in that specific major. It seems reasonable that factors that influence persistence in the first years of college would be quite different from the latter years when students are nearing degree completion, such as participating in academic intervention programming and career-related experiences. Lancaster and Xu (2017) found that as students progress into their upper-division classes in STEM, they encounter more challenging assignments and difficulty establishing new peer networks and faculty support, which presents different demands than what was required in earlier coursework. A model of student persistence that considers factors related to evolving experiences in subsequent years would provide a more extended picture of college student persistence after entrance into the institution. A protraction of this model would also provide an understanding of critical factors for persistence, in order to consider other consequential experiences and socio-cognitive motivation factors that students may encounter during their ensuing undergraduate years.

Bean's theory of student attrition. Bean's (1980, 1982, 1983b) student persistence model applies organizational process models of job turnover to emphasizes the significance of behavioral intentions (Metz, 2004; Swail, 2003). Bean synthesized Spady's (1970) and Tinto's (1975) interactional models into a new causal model adding the influences of external factors (e.g., finances, family, and job commitment), attitudinal factors (e.g., satisfaction with the institution) and behavioral intentions (Metz, 2004). Bean's (1980, 1982, 1983b) student persistence model presumes that students' behavioral intentions to persist are shaped by their attitudes, which are influenced by their experiences within the institution (Cabrera et al., 1993; Swail, 2003).

Bean further developed his model where the overall structure was based on psychological theories from Bentler and Speckhart's (1979) adaptation of Fishbein and Ajzen's (1975) attitude-behavior theory. Attitude-behavior theory argues that a strong correlation exists between attitudes, intentions, and behaviors, with behaviors and attitudes often reflecting one's intentions (Bean & Eaton's 2000, 2001, 2002; Seidman, 2005; Swail, 2003). Bean and Eaton's (2000, 2001, 2002) psychological model of college student retention asserts that "leaving college is a behavior and that behavior is psychologically motivated" (2001, p. 49). Following Bean and Eaton's (2000, 2001, 2002) model, students' entry characteristics (e.g., past behavior, normative beliefs, skills and attributes) form how they initially perceive the institutional environment. Interactions with the institutional environment then result in psychological processes that affect students' intention to persist (Braxton & Hirschy, 2005). The psychological processes specified in Bean and Eaton's (2000, 2001, 2002) model include self-efficacy, coping strategies, and locus of control. As students experience the college environment, changes to these psychological processes take place (Braxton & Hirschy, 2005). The premise of Bean and Eaton's (2000, 2001,2002) model is that students have various psychological responses to interactions within the institutional environment, which lead to academic and social integration, institutional fit and commitment, intentions to persist, and ultimately, actual persistence toward the educational outcome (Johnson, Wasserman, Yildirim, & Yonai, 2014).

A strength of Bean and Eaton's (2000) model to the study of undergraduate student persistence is the link it makes between students' psychological responses to their institutional experiences and intentions to persist. This individual-level perspective helps to identify how students' background characteristics (e.g., race, ethnicity, gender); experiences from the academic and social systems, and behaviors and attitudes interact to influence persistence decisions (Bean, 2005). Quite a few persistence studies with undergraduate students have applied this interactional framework (e.g., Cabrera, Nora, & Terenzini, 1999; Nora & Cabrera, 1996; Nora, Cabrera, Hagedorn & Pascarella, 1996; Pascarella & Terenzini, 1980). However, behavioral intentions from these interactional experiences are difficult to demonstrate; this framework does not help to explicate *why* students leave (or persist)— it only predicts which students may be *more likely* to leave (i.e., students with negative interactions with the institution; Bean, 2005).

Another limitation of Bean & Eaton's (2001) model is the generality of the psychological processes, particularly the process articulated for self-efficacy. Self-efficacy is a domain-specific construct; thus self-efficacy in one area, such as academic coursework, is not necessarily related to self-efficacy in another area, such as social interactions with peers (Mone, Baker & Jeffies, 1995). Higher education scholars using this model to examine undergraduate student persistence should evaluate self-efficacy at a level that is specific to the outcome domain (Bandura, 1986; Pajares, 1996; Zajacova, Lynch & Espenshade, 2005). In academic settings, one should measure self-efficacy with respect to the academic domain in question (Betz, 2006; Zajacova et al., 2005). Acknowledging the domain-specific aspect of self-efficacy may be useful for higher education scholars examining undergraduate student persistence in specific academic domains such as STEM.

Astin's theory of student involvement. Astin's (1984) theory of involvement is a widely-cited approach to examining undergraduate student persistence in higher education (Berger & Milem, 1997; Pascarella & Terenzini, 2005), and therefore its application to persistence is worthy of review. Astin's (1984) theory is rooted in a longitudinal study of college student persistence from which Astin (1975) concluded that factors contributing to student persistence were associated with the quality and quantity of their academic and social involvement within the institution (Berger & Milem, 1997). Astin (1984) defines involvement as "the amount of physical and psychological energy that the student devotes to the academic experience" (p. 297). In summary, Astin's (1984, 1985) theory captures five postulates, which describe student involvement as a continuous concept with quantitative and qualitative features. The model also emphasizes the types of educational initiatives institutions should take to increase involvement opportunities for their students.

Astin's (1984) theory makes important contributions to the study of undergraduate student persistence. Its strength lies in assigning the institutional environment the critical role of offering students various academic and social opportunities to become involved with other individuals on campus for an interchange of heightened experiences. However, the theory falls short in its generalization regarding involvement for it does not specify the forms of involvement experiences that are most effective toward college student persistence. This limitation becomes more salient for higher education researchers investigating persistence issues for various student populations (e.g., by race, ethnicity, gender) and in certain academic settings (e.g., STEM, public vs. private institutions, intervention programs). While the higher education literature does support forms of involvement as an important predictor of persistence, (e.g., the nature and quality of interactions with faculty and peers; Astin, 1993; Kuh & Hu, 2001; Milem & Berger, 1997; Pascarella & Terenzini, 1991, 2005), other scholars suggest that these interactions may be challenging for URM undergraduate students, particularly those majoring in STEM (Fries-Britt, Younger, & Hall 2010; Johnson et al., 2014; Newman, 2011; Seymour & Hewitt, 1997). Research has shown that Women of Color students often experience STEM contexts as unwelcoming (Palmer, Maramba, & Dancy, 2011) and isolating (Ong et al., 2011 Ong, Smith, & Ko, 2018), where they take on forms of being the "only one" of a person's race/ethnicity, or gender or both (Ong, Smith, & Ko, 2018), are excluded from study groups or overlooked on collaborative assignments (Joseph, 2012; Ko et al., 2014), and often feel “invisible” with lack of acknowledgment by peers (Johnson, Ong, & Ko, 2017). Higher education scholars using Astin’s (1984) theory of involvement to examine persistence for URM undergraduate students in STEM should consider inequities in access to various forms of involvement opportunities and how such inequities may affect URM students’ experiences and subsequent STEM major persistence decisions.

URM undergraduate student persistence. As reviewed in the preceding sections, the traditional models of undergraduate student persistence have received some criticisms for their shortcomings when examining URM undergraduate student persistence (Attinasi, 1989; Hurtado & Carter, 1997; Rendon, Jalomo, & Nora, 2000; Tierney, 1992). Within these models, the most noticeable considerations that have been left out are the differences between the experiences of URM and non-URM students, and the salience of institutional environments in URM students’ experiences and their persistence decisions (Museus, 2007). The higher education literature indicates that URM undergraduate students generally have more negative campus climate perceptions than their White peers (Ancis, Sedlacek & Mohr, 2000; Hurtado, 1992, 1994; Johnson, 2012; Kraft, 1991; Nora & Cabrera, 1996), which are formed from adverse campus experiences. Negative campus climate experiences, in turn, adversely affect persistence decisions among URM undergraduate students at predominately White institutions (PWIs) (Cabrera, Nora, & Terenzini, 1999; Museus, Nichols, & Lambert, 2008; Nora & Cabrera, 1996). Unfavorable climates within academic disciplines could further adversely affect

URM students' persistence decisions.

In their quantitative study, Cabrera, Nora, & Terenzini (1999) compared the role that perceptions of prejudice and discrimination have on the college outcomes of White and African-American students, with one outcome being the decision to persist or withdraw in the subsequent semester. Using a sample (N=2,416) from the National Study of Student Learning (NSSL), the participants in this study consisted of 1,139 White and 315 African American students attending one of 18 four-year universities in the database. The data analyses showed that perceptions of prejudice and discrimination had a large, negative effect on African American students' academic and social experiences and an indirect, but significant effect on their decision to persist. In contrast, these effects were not significant among White students.

In another quantitative study on campus climate, Museus, Nichols, and Lambert (2008) examined the relationship between campus racial climates and baccalaureate degree completion, by conducting a longitudinal ex-post facto panel survey using data from the National Center for Education Statistics (NCES) second Beginning Postsecondary Students (BPS) study. The final sample size consisted of a diverse body of undergraduate students (N=8,492) who matriculated at four-year institutions. The persistence construct was operationalized as students' degree completion after six years and the perceived campus climate construct was a dichotomous measure of whether or not a student was satisfied with the campus racial climate during their first year (Museus et al., 2008). For the African-American and Latino/a student groups, results showed a significant indirect effect of racial climate on baccalaureate degree completion, indicating that more favorable perceptions of campus racial climates were associated with degree completion.

More recent studies provide additional insight into the adverse impact of negative climate experiences on URM undergraduate students' persistence challenges (e.g., Leath & Chavous, 2018; Strayhorn, 2013). For example, Strayhorn (2013) examined student perceptions of campus climate environment and intentions to leave college among 391 White and Black undergraduate students attending a public, research-extensive predominately White institution. Seventy-six percent of the sample was White students and 24% were African American; 45% were first-year students, 23% sophomore, 14% juniors, and 18% seniors. Data were collected via the College Student Success Questionnaire (CSSQ), developed by Strayhorn using items and information from college student success and campus environments literature. Results showed that African American students' campus climate perceptions were related to their intentions to discontinue their studies. Negative perceptions of the campus climate played a significant role in determining Black students' intentions to leave college, accounting for almost one-fourth of the variance in persistence intentions.

In their quantitative study, Leath and Chavous (2018) examined racial climate, racial stigmatization and academic motivation among racially diverse women within a predominantly White university setting. They also explored Black women's racialized experiences and motivation beliefs across STEM and non-STEM majors. Black women reported more racially stigmatizing experiences, with greater uncertainty about persisting than their White and other Women of Color counterparts; results did not show many significant differences of these experiences among Black women in STEM versus non-STEM majors. Moreover, Black women's negative campus climate perceptions had a significant, positive relation to *adverse* academic outcomes such as doubt of academic ability and persistence uncertainty. The authors indicate that these negative outcomes may play a role in Black women's future academic and career decisions, including whether to stay in, or leave STEM.

The aforementioned historical and recent studies suggest that perceptions *do* matter when it comes to URM college students' persistence decisions. Overall, the higher education literature also notes that URM undergraduate students' negative campus climate perceptions adversely affect interactions with faculty and peers (Cabrera et al., 1999; Nora & Cabrera, 1996; Suarez-Balcazar, Orellana- Damacela, Portillo, Rowan, & Andrews-Guillen, 2003); academic performance (Nettles, Thoeny, & Gosman, 1986; Nora & Cabrera, 1996); and overall appraisals of the educational environment (Baird, 2000; Lent, 2005; Lent & Brown, 2006). As discussed in the next section, research examining URM undergraduate student persistence in STEM fields shows similar findings.

URM undergraduate student persistence in STEM. In their seminal study, Seymour and Hewitt (1997) interviewed undergraduate students who entered college with initial intentions to major in a STEM field, in order to compare the experiences of those who switched to non-STEM majors and those who remained in STEM. To control for academic preparation from precollege experiences, the study only included participants who scored at least 650 out of a possible 800 points on the mathematics section of the

SAT (Seymour & Hewitt, 1997). Despite these strong standardized exam scores, four themes emerged that summarized the challenges URM students had to overcome in their STEM college experiences: (1) differences in race and ethnic cultural values and socialization; (2) internalization of stereotypes; (3) racial and ethnic isolation and perceptions of racism; and (4) inadequate academic program support (Seymour & Hewitt, 1997, p. 329). These challenges may be exacerbated by the competitive and hierarchical culture perpetuated within STEM departments, particularly at predominately White four-year institutions (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009; Seymour & Hewitt, 1997). These themes highlight the multiple dimensions of challenges URM undergraduate students in STEM face in their college experiences (Newman, 2011).

The racial and ethnic isolation and socialization differentiations STEM URM students experience may be due to the lack of racial and ethnic diversity in STEM fields in academe. According to data published by the National Science Foundation (NSF, 2017), among the tenured STEM faculty at four-year institutions in 2015, 35% were White, 1.91% were Hispanic, and 1.7% were Black/African American. In 2014, undergraduate STEM enrollment at four-year institutions was 54% White, 14% Hispanic, and 12.6% Black/African American (NSF-NCSES, 2017). This lack of racial and ethnic diversity in STEM is often met with a climate that (as mentioned earlier) is also competitive and impersonal, characterized by the practice of "weeding" students out of majors and grading "on a curve" (Hyde & Gess-Newsome, 2000; Seymour & Hewitt, 1997). For example, undergraduate students intending to major in STEM often encounter their first significant obstacle in the form of STEM prerequisite courses known as “gatekeepers” (Gasiewski, Eagan, Garcia, Hurtado, Chang, 2012; Hurtado, Cabrera, Lin, Arellano, Espinosa, 2009; Seymour & Hewitt, 1997). These gatekeeper courses often result in high STEM departure rates across all students with intentions to major in STEM, but overly affect URM students, particularly those who may have entered college with little to no pre-college preparation in advanced mathematics and/or sciences (Hurtado et al., 2009; Schneider, 2000; Vetter, 1994). Additionally, the pedagogical practices in these “gatekeeper” courses, such as grading on a curve, promote intense competition among students and impersonal learning environments (Epstein, 2006; Seymour & Hewitt, 1997).

Given this representation of STEM environments, the higher education literature suggests that the climate in STEM may induce difficult faculty and peer interactions (Fries-Britt et al., 2010; Newman, 2011); poor learning experiences (Seymour & Hewitt, 1997); adjustment challenges (Hurtado et al, 2007); and compromised self-perceptions of academic ability in STEM (Byars-Winston, 2010; Schunk & Meece, 1992). Fries-Britt, Younger and Hall (2010) conducted a qualitative study to understand the academic, social, and racial experiences of URM undergraduate students (N=110) majoring in physics. Among several types of experiences, Fries-Britt and colleagues (2010) examined interactions with STEM faculty. Participants reported on the tone faculty used to speak with them and cited a lack of approachability among many of their STEM faculty. A common experience among these URM physics students was the feeling that their professors tried to discourage them from science by either blatantly recommending they find another major or by ignoring their contributions in the classroom.

In another qualitative study on students' interactions with STEM faculty, the results were more mixed. Newman (2011) explored the experiences of African American engineering undergraduates (N=12) with university faculty members at three four-year higher education institutions. The overall findings suggested that faculty members played an important role in encouraging or dissuading URM students to persist in their respective engineering majors. The participants cited examples of both faculty members that were inspiring (e.g., providing research opportunities) and those that were discouraging (e.g., low expectations and apathetic attitudes towards engaging students in class settings) to their academic and career goals in STEM. Students' experiences with faculty having low expectations convey an important implication of faculty member's approaches to undergraduate instruction. Faculty members who teach undergraduate engineering and other STEM gatekeeper courses and are disengaged in teaching such courses may promote similar feelings of disengagement among students enrolled in these courses. Such disengagement among URM students at predominantly White universities where the numbers of URM peers may be small further heightens students' difficulties in the STEM academic community (Newman, 2011). The key point from both studies is that *faculty play a key role* in the learning process for URM undergraduate students in STEM, and the interactions faculty have with URM undergraduate students plays an important role in their academic persistence in STEM (Newman, 2011). In support of this assertion, a mixed-method study by Gasiewski and colleagues (2012) demonstrated how more active faculty pedagogical strategies in STEM gateway courses could enhance student engagement.

Poor learning experiences are another aspect of adverse STEM academic environments that may affect URM students' decision to remain in STEM. In their descriptive study, Songertoth and Stough (1992) captured the learning and STEM persistence experiences of URM undergraduate students (N=38) attending a four-year university, majoring in engineering. Their analysis showed that both students who continued in engineering and students who switched to a non-STEM major reported experiencing a "hostile system". This sentiment was articulated most strongly by students who felt that professors were trying to "weed them out" of courses, and who were not concerned with whether or not they learned. Other sentiments expressed included: the disconnection between the lectures and exams; the method of grading on a "curve", and the practice of professor not granting partial credit for demonstrated efforts. Students also expressed that the climate was competitive and set up to be defeating. These poor learning experiences attributed to twelve (out of 38) URM students who were identified as "high" achievers departing from engineering majors. The comments expressed by the URM undergraduate students in Songertoth and Stough's (1992) study speak volumes to the inadequate existing pedagogy and instructional quality in many STEM courses (Espinosa, 2011).

A final aspect of adverse STEM environments that may affect URM persistence is their sense of college adjustment. To understand the impact of diversity in STEM on URM undergraduate student adjustment, and other factors related to persistence strategies, Hurtado and colleagues (2007) conducted a longitudinal study using data from the Higher Education Research Institute's 2004 Cooperative Institutional Research

Program (CIRP) Freshman Survey (TFS), and the 2005 Your First College Year Survey (YFCY). The final sample (N=5,047) included 1,850 URM STEM majors, 1,366 White/Asian STEM majors, and 1,832 URM non-STEM majors. At the end of their first year in college, students completed survey measures to capture their sense of adjustment and competence. Results for URM students indicated significant negative effects of climate on their sense of adjustment and moderating effects of their assessment of their individual academic performance. While a limitation of this study is that the researchers did not disaggregate the data for differences that may exist for the subgroups of URM students (STEM vs. non-STEM), the results still reveal that academic environmental climate has an effect on predictive persistence factors for URM undergraduate students.

While much of the research on undergraduate student persistence continues to highlight the need for students to become academically and socially integrated, involved, and committed to the university— and are driven primarily by reformulations of Tinto's (1993), Bean and Eaton's (2001) and Astin's (1984, 1993) models— what is shown from the studies on URM undergraduate students is the salience and impact of institutional and STEM climates (e.g., in departments broadly, and specific courses). Furthermore, the studies reviewed demonstrate the effect adverse climates could have on URM STEM undergraduate students' learning and social experiences with faculty and peers. As students undertake these arduous environments, their subjective sense about how to mitigate these experiences and successfully perform in these contexts may be compromised and ultimately alter their initial decisions to persist. A particular effort designed to assuage these complex adverse experiences and improve retention and degree completion in STEM among historically URM students is undergraduate research programming. In the next section, undergraduate research programming and the impacts of participation for URM students are discussed.

Research Experiences for Undergraduates

Faculty-mentored undergraduate research experiences are nationally recognized as strategic efforts to address underrepresentation in STEM (e.g., Bailey, 2015; Bowman, 2011, 2013; DePass & Chubin, 2015; Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013; Hernandez, Woodcock, Estrada, Schultz, 2018). Colleges and universities have administered faculty-mentored undergraduate research programming as a way to retain historically underrepresented students in STEM majors, enhance their educational experiences, and serve as a pathway toward advanced STEM career outcomes (e.g., Barlow & Villarejo 2004; Jones, Barlow, & Villarejo, 2010; Nagda, Gregerman, Jonides, von Hippel, & Lerner 1998; Schultz et al., 2011). Undergraduate research typically involves collaboration with a faculty expert on a research topic in an environment that emphasizes high levels of achievement, provides scaffolding for development of strong research and problem-solving skills, and fosters academic peer support, including support from graduate students (Baiduc, Drane, Beitel, & Flores, 2017; Eagan et al., 2013). This training is believed to incite continued interest in the scientific process, which may lead to persistence in the field of research and increased educational and long-term career intentions in STEM (Eagan et al., 2013; Russell, Hancock, & McCullough, 2007; Seymour, Hunter, & Laursen, 2004).

Benefits of research experiences for undergraduates. Empirical studies have investigated a range of positive outcomes emerging from undergraduate research programming participation. One prevalent outcome is the positive effect on student retention in STEM majors (e.g., Barlow & Villarejo, 2004; Chang, Sharkness, Hurtado, & Newman, 2014; Nagda et al., 1998). Using longitudinal data from the Cooperative Institutional Research Program (CIRP)'s 2004 *The Freshman Survey* (TFS) and 2007-2008 *College Senior Survey (CSS)*, Chang, Sharkness, Hurtado, and Newman (2014) found that participation in undergraduate research significantly predicted the likelihood of historically URM students fulfilling their freshman year intentions to major in a STEM discipline; the 2007-2008 CSS followed up with the same group of students from the 2004 TFS after their fourth year in college (Chang et al., 2014). URM students who participated in undergraduate research programming were more likely to persist in STEM by 17.4 percentage points more their than URM counterparts who did not participate in undergraduate research (Chang et al., 2014). Moreover, among five college experiences that significantly predicted the likelihood of URM students achieving their first year STEM intentions, participation in undergraduate research experiences was the strongest of the five predictors.

In another study on the effects of undergraduate research programming on retention, Barlow and Villarejo (2004) examined the Biology Undergraduate Scholars Program (BUSP) at the University of California, Davis (UCD); an intensive undergraduate research program for undergraduates who have a strong interest in the biological sciences. BUSP was established to specifically address racial/ethnic disparities in biological sciences graduation rates at UCD. (Barlow & Villarejo, 2004). When comparing those students who entered UCD between 1988 and1994 and accepted the invitation to participate in BUSP to those who entered during the same period by declined the offer, Barlow and Villarejo (2004) found that BUSP participation improved overall college completion rates. In terms of degree completion, participation in BUSP was associated with an almost 50% increase in odds of graduating with a degree in biology. Furthermore, student researchers had more than four-fold greater odds of graduating with a degree in biological sciences broadly, and more than seven-fold greater odds of earning a degree in biology than non-BUSP participants. Barlow and Villarejo (2004) concluded that introducing students to undergraduate research early on is especially beneficial for URM student retention and performance.

In one of the few studies to employ a randomized design, Nagda and colleagues (1998) investigated retention outcomes of applicants for the Undergraduate Research Opportunity Program (UROP), at the University of Michigan. UROP provides first-year students and sophomores with a mentored research project, including peer advising and skill-building workshops (Nagda et al., 1998). The program is open to all students with a targeted emphasis on URM students interested in the sciences. Nagda and colleagues (1998) found that for student applicants who were randomly selected to participate in UROP, there was a statistically significant increase in retention rates (in the major) compared to those who did not participate; this effect varied by racial/ethnic groups, with the largest UROP versus non-UROP difference in major retention rates occurring among African Americans students. In addition, Non-Hispanic white students who had participated in research showed half the STEM attrition rate of the matched control group of Non-Hispanic white students, though the difference was not statistically significant. Moreover, Hispanic UROP students had a slightly higher, though not statistically significant, retention rate with their matched control non-UROP group.

The programs described above demonstrate that undergraduate research experiences may improve STEM retention and degree completion among underrepresented students (Jones, Barlow, & Villarejo, 2010). Undergraduate research experiences may also initiate consideration for graduate school and facilitate the process of preparing students for advanced careers in STEM. The following sections discuss the impact of undergraduate research programming on advanced STEM career plans.

Undergraduate research and the graduate school-to-research career pipeline. Another overarching goal of undergraduate research programming is to promote interest in graduate education and faculty research careers. Along the STEM pipeline, the pursuit of advanced degrees continues to be a point where URM students drop in disproportionate numbers (Astin, Tsui, & Avalos, 1996; Girves, Zepeda, & Gwathmey, 2005). The Council of Graduate Schools reports that URMs continue to lag their White counterparts in graduate degree pursuit and attainment. In 2016, among U.S. citizens and permanent residents of all first-time graduate enrollees, 11.8% were Black/African American, and 10.9% were Hispanic/Latino, while White students accounted for 60.7% (Okahana & Zhou, 2017). Of the research doctorates awarded in 2015, African Americans earned 6.5% and Latinos 7.0% (NSF & National Center for Science and Engineering Statistics, 2017). To bridge the pathway to advanced degrees, undergraduate research programs have been found to increase interest in and knowledge of research and higher educational aspirations, such as an enhanced commitment to graduate education, doctoral degrees, and research careers (Gum et al., 2007).

Faculty-student interactions during undergraduate research experiences play a pivotal role in students' decisions to pursue further education (Eagan et al., 2013; Hathaway, Nagda, & Gregerman, 2002; Thiry & Laursen, 2011). These faculty-student relationships in which undergraduates work under faculty guidance on faculty research projects may be conceived as mentoring relationships (Hathaway et al, 2002). The academic influence and benefits of mentoring prove particularly valuable toward the cultivation of intellectual skills and subsequently, positions students to be better prepared to pursue graduate education (Davis, 2010). Jacobi (1991) identifies four theoretical approaches that assist in understanding the connection between mentoring and academic success: (a) involvement in learning; (b) academic and social integration; (c) social support,; and (d) social and cognitive development (Davis, 2010). In the first theoretical approach, mentoring is viewed as facilitating student involvement, learning through the mentor's encouragement, and providing opportunities for such involvement, such as a research experience (Davis, 2010; Jacobi, 1991). In the second approach, Jacobi (1991) refers to integration as "student attitudes, feelings, and self-concept in assessing the outcomes of mentoring" (p. 524). Social support as the third approach may come in the form of emotional support such as *appraisal support* through affirmation and feedback, and *information support* such as advice (Davis, 2010; Jacobi, 1991). Fourth, developmental theory assesses students' cognitive, social, and personal development, and tailors mentoring accordingly (Davis, 2010; Jacobi, 1991). Mentorship programming based on these four theoretical approaches assists students in the pipeline to graduate school and toward careers in academe (Davis, 2010; Jacobi, 1991). Undergraduate research experiences that provide mentoring from members of the professoriate and research experiences help to address the lack of representation of minorities among individuals who complete competitive research oriented doctoral programs (Davis, 2010).

Faculty mentored undergraduate research experiences also play a key role in professional socialization, defined as the transference of knowledge and skills in a given profession (Davis, 2010). Bowman and Stage (2002) used the term "disciplinary socialization" (p. 123) to typify "the process by which a student becomes familiar with the process of professional performance and discourse in the academic sciences" (p. 123). Early exposure to research provides students with important socialization opportunities within their intended academic field of study while influencing their research occupation trajectories and aspirations (Davis, 2007). Undergraduate research experiences also extend opportunities for students to attend and present at academic conferences, and publish scholarly articles, which are representations of research career socialization processes (Clewell, Cosentino de Cohen, Tsui, & Deterding, 2006). Participation in this process allows students to internalize the conventions of their academic discipline and prepares them for research-oriented graduate programs (Clewell et al., 2006; Davis, 2007).

Summer Research Opportunity Program

The present study focuses on the ***Summer Research Opportunity Program (SROP)***, which is a nationally-recognized, faculty mentored-centered undergraduate research program designed to prepare students for graduate education and research careers. Initiated by the ***Big Ten Academic Alliance (BTAA)*** Graduate Deans in 1986, SROP targets rising juniors and seniors with programming organized around a hands-on research project under the supervision of a faculty mentor, professional development workshops, and participation in a research conference in an effort to introduce these students to the research enterprise. (Allen & Zepeda, 2007, Bowman & Ebreo, forthcoming). During the summer at 14 BTAA research universities, selected SROP participants receive a stipend and spend 40 hours per week for 8-10 weeks during the summer working with a faculty research mentor while actively participating in a comprehensive set of supportive activities such as workshops on navigating the graduate school application process and completing preparation courses for the Graduate Record Examination (GRE).

The BTAA-SROP has demonstrated particular efficacy for promoting successful STEM outcome among underrepresented students (Bowman & Ebreo, forthcoming), serving as a pivotal gateway to graduate education and research careers by providing close to 12,000 undergraduate research experiences at the 14 BTAA universities with over 3,000 of previous participants who have pursued graduate studies (Zepeda & Farber, 2010; Bowman & Ebreo, forthcoming). The BTAA central office has tracked over 610 SROP alumni who have earned PhDs and several thousand who have completed other graduate/professional degrees and are pursuing careers in a range of STEM fields (Bowman & Ebreo, forthcoming). A long-term goal for SROP is to serve as a bridge— particularly for underrepresented students— to graduate studies and faculty research careers (Bowman & Ebreo, forthcoming).

The data for this study comes from SROP student applicants who have an interest in academic research careers. Given that a number of SROP applicants study STEM areas, it is an appropriate context to examine STEM outcomes for those students. In 2009, STEM majors represented more than half (57%) of SROP interns, with the largest group in the life sciences (31.8%), followed by the social sciences (31.6%), physical sciences (16.8%), and engineering (8.6%) (Zepeda & Farber, 2010). Additional details on SROP and the current study sample are provided in the Methods (Chapter 4).

The literature in the previous sections identified a broad range of undergraduate research programming benefits for students, particularly for those who participate in the BTAA-SROP which is specifically designed to increase the number of students from underrepresented groups who enroll and graduate from graduate programs at BTAA universities (Zepeda & Farber, 2010). However, despite the efficacy of exemplary undergraduate research program interventions, there is a growing interest in more theory-driven studies to better understand why some participants benefit from formal intervention activities more than others. Rigorous outcome evaluation studies show clear average benefits for intervention participants over control groups—but do not explain differential benefits among participants *within* intervention groups. Increasing the participation of Women of Color in STEM— especially at advanced levels (e.g., the professoriate) — remains a major national challenge with theoretical research and higher education policy implications. This underrepresentation issue has attracted considerable interest from the National Academy of Sciences (NAS), National Institutes of Health (NIH) and the National Science Foundation (NSF), and other relevant stakeholders that desire to apply theoretical models to better understand mechanisms which promote scientific research careers among talented participants from URM groups. This study takes one such theoretical model, social cognitive career theory, a foundational social cognitive theory in psychology, to assess the relationships of socio-cognitive motivation and STEM persistence plans among Women of Color. The next section describes the need for theory-driven studies on the experiences of Women of Color in STEM.

STEM Persistence among Women of Color: The Need for Theory-Driven Studies

The ongoing underrepresentation of Women of Color in STEM establishes the need for more theory-driven studies to address this concern. The present study focuses on STEM persistence challenges facing Women of Color who applied to the BTAA-SROP as undergraduates with *strong academic preparation* as well as an *expressed interest* in both Ph.D. studies and faculty research careers. Although higher education scholars have advanced our understanding of undergraduate student persistence in general (e.g., Astin, 1984, 1993; Bean, 1982, 1985; Berger & Milem, 1999; Cabrera et al., 1993; Pascarella & Terenzini, 1991, 2005; Tinto, 1975, 1993), current knowledge of the various factors that contribute to STEM persistence for specific race and gender groups, particularly among Women of Color, continues to elude scholars after more than forty years of research. In the few existing theory-driven empirical studies that *do* seek to explain differences in baccalaureate degree completion rates by race and gender, higher education researchers frequently draw on traditional college departure theoretical frameworks (to study persistence) (Cabrera et al., 1993). However, these college departure models (e.g., Bean, 1985; Tinto 1975, 1993) used to study URM students' persistence, and especially Women of Color's persistence in STEM, is problematic for several reasons.

The traditional college departure models have three major limitations for guiding STEM persistence research on Women of Color. The first limitation is that these models are all encompassing; they do not delineate factors by field of study and/or other academic-related contexts (Ceglie, 2009). Factors considered highly salient to students in STEM majors might be negligible to students in non-STEM majors. Adding the complexity of persistence issues present among Women of Color makes these models evermore incomplete (Ceglie, 2009). First, in STEM academic disciplines in particular, Women of Color must navigate competitive and hierarchical academic environments (Hurtado et al., 2009) compounded with dominant cultural and social constructions (Torres, 2010). A second concern is that researchers have employed traditional college departure models in the same manner to predict persistence factors of both URM and non-URM students (Rendon, Jalomo, & Nora, 2000). While there have been many factors that may unquestionably overlap and play a role in persistence among all college students (e.g., high school GPA, entrance exam scores), researchers examining other demographic influences on persistence have found that race, gender, socioeconomic, and first-generation status are also influential predictors (Chen & Soldner, 2013; Ishitani, 2016; Riegle-Crumb, King, Grodsky, Muller 2012). Examining bachelor's degree STEM entrants for the U.S. Department of Education analysis report, Chen (2013) found proportionally more females than males left STEM fields (32% vs. 26%); Asians left STEM at the lowest rate of all racial/ethnic groups (10% vs. 20%-29%); and students whose parents attained a high school education or less left STEM fields at a higher rate than their counterparts whose parents earned a bachelor's degree or higher.

A third concern is while most higher education researchers agree that individual background factors, institutional factors, academic and social systems within the institution, and the various forms of interaction of these constituents all play a role in student departure, much less attention has been given to understanding how students (individually) arrive at departure decisions from these interactions, and investigating multilevel social and psychological mechanisms to better explain career choice, commitment and development. Furthermore, traditional college departure models do not address socio-cognitive motivation variables that may be related to career decisions among Women of Color. The dominant disciplinary culture within STEM, which largely reflects White masculine norms, is often at odds with the values and needs of many students of color and women (Carlone & Johnson, 2007; Garibay, 2013; Johnson; 2011; Seymour & Hewitt, 1997). When examining the experiences of undergraduate students who left STEM, Garibay (2011) found that URM and non-URM students distinctly differed on the value they placed on working for social change, with 59% of URM students indicating that working for social change was important to their future career goals compared to 41% of their non-URM counterparts. In their qualitative study examining the undergraduate and graduate science experiences of fifteen Women of Color, Carlone and Johnson (2007) found that most of the women saw science as a way to express their altruistic values and conduct research that improves lives. Taken together, these findings support further investigation on the role of socio-cognitive motivation and STEM persistence plans among Women of Color. Understanding the socio-cognitive motivation processes may fill this gap in how and why Women of Color make career decisions in STEM. Furthermore, as suggested by Herrera and Hurtado (2011), a better integration of *both* social and psychological perspectives to the examination of collegiate experiences adds a layer of depth to scholarly inquiry and provide insights into how socio-cognitive motivation factors impact STEM career persistence among Women of Color and other underrepresented groups.

Applying social cognitive career theory (SCCT) to address limitations in the existing literature with on college student persistence may help to better explain key motivational and contextual mechanisms that promote STEM persistence. SCCT places a particular emphasis on the role of social cognitive factors in career choice, persistence, and related outcomes (e.g., Betz & Hackett, 1981; Gainor, 2006; Hackett, 1995; Hackett & Betz, 1981; Lent & Brown & Larkin, 1984, 1986, 1987; Lent, 2005). The next section presents SCCT, its major concepts and related research on STEM persistence.

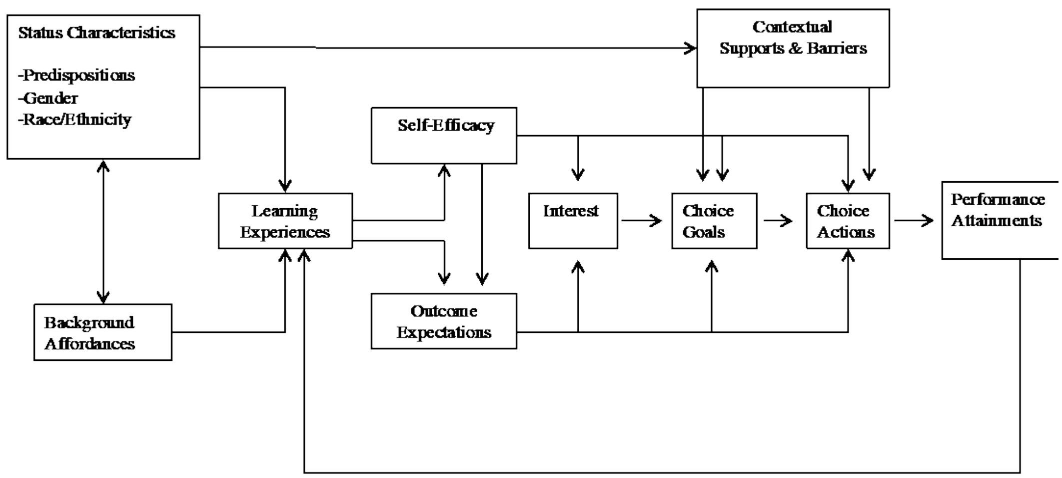
Chapter 3 Social Cognitive Career Theory Reformulation and Research Questions

This investigation contributes to a better understanding of the pivotal socio-cognitive factors that shape the STEM career-related interest, choices, and STEM persistence plans among Women of Color. This dissertation has important theoretical and practical significance. Theoretically, this study extends ***social cognitive career theory*** **(SCCT)** to better understand STEM career-related issues facing Women of Color. A practical goal is to help educational practitioners and policy-makers to better understand socio-cognitive factors that may strengthen Women of Color's decisions regarding STEM careers during the undergraduate-to-post graduate pipeline.

The limited empirical research on career choice and development among underrepresented minority students, and of Women of Color particularly, offers little insight on their career intentions, socio-cognitive appraisals, and other factors that also determine STEM persistence outcomes (Hanson, 2004). We may examine persistence in an academic major more comprehensively if we better understand how students make career decisions and the pivotal factors that facilitate or impede this process. SCCT is a theoretical framework that considers social and psychological mechanisms guiding career development (Tang, Pan, & Newmeyer, 2008). SCCT places emphasis on the reasons why individuals select, change, and continue in particular careers (Brown & Brooks, 1990).

Building upon the initial work of Bandura's (1977) basic social cognitive theory in psychology, and the subsequent work of Betz and Hackett (1981), SCCT was developed to help explain the interplay among person and contextual variables during three phases of the career development process: (1) the emergence of academic and vocational interests; (2) choosing an academic major and relevant career path, and; (3) the pursuance of educational and occupational endeavors (Lent, Brown, & Hackett, 1994). For over 35 years, a substantial body of theoretical and empirical research increasingly supports the basic propositions of SCCT with a particular emphasis on the pivotal role self-efficacy has on a range of career development outcomes (Betz & Hackett, 1981; Gainor, 2006; Hackett, 1995; Hackett & Betz, 1981; Lent, 2005; Lent & Brown & Larkin, 1984, 1986, 1987). SCCT provides researchers a framework to examine how interactions, between individuals and their environment, impacts their career-related learning, socio-cognitive appraisals, motivation and behaviors (Bandura, 1977, 1986, 1997). A central tenet of SCCT is that individuals' evaluations and interpretations of their own experiences and performance attainments informs and modifies their self-beliefs; in turn, self-beliefs influence their subsequent behaviors (Pajares, 1996).

As suggested by the common conceptual model in Figure 3.1, SCCT postulates that self-efficacy is the *central* social-cognitive variable that motivates STEM career interests, goals and actions such as persistence. As illustrated, a second central SCCT proposition is that self-efficacy also influences outcome expectations, *which* also further influence career interests, goals and persistence. A third core SCCT proposition is that learning experiences are major sources of self-efficacy and outcome expectations. Fourth, SCCT views learning experiences as directly determined by background affordances (e.g., precollege academic experiences, access to advance placement courses during high school) and related personal antecedents such as gender and race/ethnicity. Finally, SCCT also acknowledges that such antecedents can also operate through more proximal environmental supports and barriers to directly influence goals and persistence. Next, I will define major concepts in SCCT and highlight related research.



Adapted from: Lent, R., Brown, S., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45*(1), 79–122.

Figure 3.1: Traditional Social Cognitive Career Theory; A conceptual model.

The Self-Efficacy Concept in Social Cognitive Theory

According to Bandura's (1977, 1982, 1997) social cognitive theory, how individuals evaluate and interpret their own experiences and performance attainments informs and modifies their self-beliefs, which in turn informs and ultimately determines their subsequent behaviors (Pajares, 1996). The major concept in social cognitive theory is *self-efficacy beliefs*, an extensively researched psychological construct defined by Bandura as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (1997, p. 3). According to social cognitive theory, one's self-efficacy beliefs influence the initiation of behavior, the effort expended in a behavior, and the degree of behavioral persistence in the face of obstacles (Gore Jr., Leuwerke, & Turley, 2006). Self-efficacy also influences the interpretation and affective reactions of feedback from various sources within the observed domain or context (Gist, Schwoerer, & Rosen, 1989; Kanfer & Ackerman, 1989), and can also be modified as a result of sequential experiences and feedback (Gist & Mitchell, 1992). In an academic context, information derived from the individual student, the academic task, and others in the academic environment contribute to an individual's assessment of his or her capability to perform academic tasks within the context (Gist & Mitchell, 1992). As a construct derived from social cognitive theory, self-efficacy is used to examine how sources of experiential information influences appraisals or judgments of an individual's future performance attainments. Motivation, which is primarily concerned with the activation of behavior (e.g., actual persistence), is derived from cognitive activities (e.g., undergraduate research experiences) (Bandura, 1977a). Self-efficacy provides a cognitively based source of motivation operating through the intermediating influences of self-evaluative reactions (Bandura, 1976, 1977b). Individuals can (choose to) induce their motivation of the actual behavior through their cognitive accounts of self-evaluative judgments (beliefs) that they can successfully produce a certain goal outcome (Bandura, 1977a).

The self-efficacy concept is increasingly employed in higher education literature to examine its relationship to a range of academic outcomes. For example, Russell and

Petrie (1992) suggest that self-efficacy beliefs combine with academic, social, and environmental factors to predict student college adjustment. Peterson and Delmas' (2001) study demonstrated significant relationships between career decision-making self-efficacy beliefs, degree utility, and persistence indicating potential overlaps across social cognitive, career development, and student retention theories (e.g., Bandura, 1977; Bean, 1980; Tinto, 1975, 1987). Other researchers have demonstrated relationships between self-efficacy beliefs for specific academic subjects and domains, and academic persistence (Lent, Brown, & Larkin, 1984, 1987; Multon, Brown, & Lent, 1991). To further clarify the construct of self-efficacy and its utility toward examining undergraduate student persistence, the next sections will bring attention to how the construct is defined and assessed, and highlight the sources that determine self-efficacy beliefs.

Specificity. Self-efficacy is a multidimensional construct that varies according to the domain or context of the behavior required (Zimmerman, 2000) and therefore should be examined in a specified outcome domain (Bandura, 1986; Pajares, 1996; Zajacova, Lynch, & Espenshade, 2005). In other words, self-efficacy beliefs are more behaviorally specific rather than general and therefore should have a behavioral reference to be meaningful (Betz, 2000). Thus, in academic settings, one should measure academic self-efficacy beliefs with respect to the academic domains of behavior that can be postulated rather than generalized self-efficacy (e.g., mathematics self-efficacy should be measured to examine persistence in mathematics majors) (Betz, 2006; Zajacova et al., 2005).

Level, strength, and generality. Bandura (1997) conceptualized self-efficacy as varying along three dimensions: level, strength, and generality. *Level* refers to the degree of difficulty of the behaviors or tasks that an individual feels capable of performing successfully within a given behavioral sequence or domain (Lent & Hackett, 1987). *Strength* refers to the confidence an individual has in his or her ability to successfully perform required tasks within a specified domain. Weak self-efficacy beliefs are easily perpetuated by disconfirming experiences, while strong self-efficacy beliefs are robust and will persevere in the face of obstacles (Bandura, 1997). *Generality* of self-efficacy concerns the range of situations in which an individual considers himself or herself to be efficacious (Lent & Hackett, 1987). Individuals may judge themselves efficacious across a wide range of activities or only in certain domains of functioning (Bandura, 1997).

Self-Efficacy, Outcome Expectations and Contextual Factors

In addition to self-efficacy, SCCT also focuses on the explanatory power of *outcome expectations*— defined as beliefs regarding the consequences or outcomes of performing particular behaviors (Bandura, 1977, 1986). SCCT suggests that outcome expectations primarily mediate effects of self-efficacy; however the broader expectancy-value theory literature suggests that these two social cognitive independent variables may also have important interaction effects (e.g., Feather, 1982). Another focus takes into consideration contextual factors. SCCT posits that contextual supports and barriers may sometimes operate as moderating the processes whereby people translate their career interests into goals and their goals into actions. Furthermore, researchers employing SCCT assert that contextual supports and barriers mediate persistence through their effect on self-efficacy (Byars-Winston et al., 2010; Byars-Winston & Fouad, 2008; Lent et al., 1994, 2000, 2003, 2005). In this study, “supports” are factors that encourage achievements related to pursuing a career in STEM. “Barriers” refer to factors that can interfere in the process of attaining a career in STEM (Herrera & Hurtado, 2011).

Major sources of self-efficacy and outcome expectations. According to Bandura (1997), once self-efficacy beliefs are initiated and formed, they are not fixed. Self-efficacy beliefs are subject to change because the individual is constantly evaluating new information from more advanced levels of experiences he or she may encounter. However, once self-efficacy beliefs have been established over long periods of time, they are less likely to vary. A major proposition in SCCT is that social learning experiences in various contexts are the major determinants of career self-efficacy, which, in turn, influences outcome expectations, goals, and interests that determine career development outcomes. Bandura’s basic research on social cognitive theory identified four major sources of self-efficacy beliefs: (1) *verbal persuasion or social encouragement*; (2) *vicarious learning experiences*, especially from culturally similar role models; (3) *mastery experiences* based on a person’s own successful performance accomplishments; and (4) *emotional arousal* including a person’s negative affective or physiological states. Related research supports the significant impact of these various sources on self-efficacy beliefs, with clear evidence that self-efficacy is especially modified by sequential experiences and feedback (e.g. Bandura, 1977; 1986; 1997; Gist & Mitchell, 1992). Bandura (1997) highlights an extensive body of empirical research that supports the centrality of these four primary sources of information in the development and modification of self-efficacy beliefs. Although these sources of information influence self-efficacy beliefs, it is the individual's cognitive appraisal and integration of these experiences that ultimately determine self-efficacy (Bandura, 1982; Gist & Mitchell, 1992). The following four subsections (social and verbal persuasion, vicarious experiences, mastery experiences, and emotional and affective states) will describe the four determinants of self-efficacy in order to further understand the primary sources within one's academic environment that may enhance or weaken self-efficacy beliefs as they pertain to URM undergraduate student persistence in STEM.

Social and verbal persuasion. Verbal persuasion refers to verbal information and messages conveying encouragement or discouragement (Hackett & Byars, 1996). Persuasive communication and evaluative feedback as a source of self-efficacy is most effective when the ones who provide this information are viewed as knowledgeable and trustworthy, and the information is practical (Bong & Skaalvik, 2003; van Dinther et al., 2011). Somewhat similar, social persuasion implies a social support system that believes in an individual's capabilities to perform a task as well as provide feedback and encouragement (Rogers & Summers, 2008). In both forms, whether verbal or social, positive feedback heightens self-efficacy, while the "lack of encouragement and blatant discouragement is very likely to negatively influence or weaken self-efficacy beliefs" (Hackett & Byars, 1996, p. 334).

A partial explanation for URM undergraduate students' departure from STEM may be attributed to messages that discourage them from completing a degree in STEM. For example, the accumulation of daily, verbal, behavioral, or environmental microaggressions (Sue et al., 2007) — commonly experienced by URM undergraduate students in STEM (McGee & Martin, 2011; Moore, Madison-Colmore, Smith, 2003)—can affect their perceptions of campus and departmental climate and their academic performance, which can lead to changing majors (Byars-Winston et al., 2010; Solórzano, Ceja, & Yosso, 2000). Furthermore, given smaller URM populations in both STEM faculty and the student body as reviewed previously, support systems may also be harder to come by for URM undergraduate students attending predominately White institutions where they may find themselves lacking sufficient verbal and social encouraging sources of self-efficacy (Rogers & Summers, 2008).

Vicarious experiences. The second source of creating self-efficacy is through observational experiences provided by social models (Bandura, 1997). A vicarious experience as a source of self-efficacy is created when an individual has a shared identification with others and sees his or her abilities and circumstances as similar (Rodgers & Summers, 2008). "The greater the assumed similarities the more persuasive are the models' successes and failures" (Bandura, 1995, p. 3). The visibility of URMs in STEM careers and educational settings is a critical factor for URM students intending to pursue STEM degrees, as researchers have found that the lack of sufficient role models in STEM fields contributes to URM undergraduate students' questioning whether or not a career in STEM is viable and achievable (Good, Halpin, & Halpin, 2000; Hackett & Byars, 1996; May & Chubin, 2003; Newman, 2011). When URM students observe those serving as role models succeed in STEM fields, they may acknowledge that they have the potential to succeed in STEM as well (Brown & Inouye, 1978; Museus, Palmer, Davis, & Maramba, 2011; Murphey & Arao, 2001).

Mastery experiences. Mastery experiences are personal accomplishments from previous performance experiences within the same performance domain. Individuals evaluate the results of their past experiences performing a task within a specified domain, and use these assessments to develop beliefs about their capability to perform subsequent similar tasks or activities within the same domain (van Dinther, Dochy, & Segers, 2011). These mastery experiences are considered the most powerful source of creating a strong sense of self-efficacy because they provide authentic evidence that one has the capability to succeed in similar future tasks (Palmer, 2006; van Dinther et. al., 2011). In an academic setting for example, this means having a positive experience in completing a particular course in a major or field of study, and based on that experience, having the belief in the capability to continue on to advanced courses in that major or field of study (Marra, Rodgers, Shen, & Bogue, 2009). Students who are provided opportunities to learn, practice, and master course content are likely to develop a strong sense of academic self-efficacy and enroll in subsequent like courses and related experiences (Rittmayer & Beier, 2008).

Emotional and affective states. Physiological and affective states pertain to an individual's beliefs in his or her ability to cope with the stressful vagaries of life (Bandura, 1997). This source of self-efficacy information draws on one's emotional, physiological, and dispositional states (van Dinther et al., 2011). Individuals rely in part on these states in assessing their capabilities when perceiving and interpreting self-efficacy information in conjunction with the other three sources (Pajares, 1997). The research is not clear about the extent to which physiological and affective states inform self-efficacy and subsequently influence undergraduate student persistence. Theoretically, students with a higher sense of self-efficacy will view a state of tension as motivating in the face of obstacles while those who have a lower sense of self-efficacy may interpret their tension as a form of deficiency (Hackett & Byars, 1996; van Dinther et al., 2011).

In summary, while individuals construct their self-efficacy beliefs through the interpretation from each of these four sources, it is important to note that these sources of information often operate concurrently (Pajares, 1997; Zeldin, Britner, Pajares, 2008; van Dinther et al., 2011); individuals often experience success and failure, encouragement and discouragement, in an endeavor (e.g., pursing an academic degree) at the same time. The strength of the contribution made by each source varies depending on the task and domain in question. The manner in which the multiple sources of information are weighed and combined influences the resulting self-efficacy (Zeldin et al., 2008). It is this cognitive processing and integration of information from multiple sources that determines an individual's self-efficacy beliefs (van Dinther et al., 2011; Zeldin et al., 2008).

Research on contextual factors and self-efficacy. Guided by SCCT propositions, there are a few studies that focus on the relationship between contextual supports and barriers within the institutional environment and self-efficacy (e.g. Lent et al, 2003; Lent et al, 2005). To examine the role of contextual supports and barriers to academic outcomes in STEM, Lent and colleagues (2003) designed a study to explore the relationship of contextual supports and barriers to (engineering) self-efficacy, educational goals, and persistence. Participants were undergraduate engineering students (N=238) enrolled at a four-year university. The sample was primarily comprised of first-year students, with some sophomores and juniors. Thirteen percent of the participants were URM students. Persistence was measured across three consecutive semesters. In testing two models of the paths by which contextual supports and barriers relate to persistence, both models showed that supports and barriers were related to persistence indirectly through self-efficacy and educational goals. However, supports and barrier variables produced significant paths only to self-efficacy. This result demonstrates that contextual variables can serve as sources of self-efficacy information, meaning students may estimate their capabilities based partly on the nature of the supports and barriers they expect to encounter (Lent et al., 2003). A limitation to this study is that the small sample size of URM students did not allow for specific findings within this group.

In another study to examine the role of contextual supports and barriers to academic outcomes in STEM, Lent and colleagues (2005) investigated the role of SCCT in predicting STEM interests and major choice goals among engineering students enrolled at two historically Black universities (HBCU) and one predominantly White university. Participants (N=487) completed measures of academic interests, major choice goals, self-efficacy, outcome expectations, and contextual supports and barriers in relation to persisting in their engineering majors. In this study, the "major choice goals" variable was operationalized as an individual's intention to select or remain in a particular STEM major. Regarding the roles of contextual supports and barriers relative to STEM major choice goals, path analyses showed both support and barrier factors were significantly associated with self-efficacy in the sample as a whole as well as in the analyses by university type. However, the paths between supports and barriers were larger for the students attending the two HBCUs than in the predominantly White university sample, which may suggest that the contextual supports provided in the HBCU environments were particularly helpful at offsetting contextual barriers (Lent et al., 2005). A limitation to this study is that it examined differences in STEM major choice goals by university type rather than by race/ethnicity, particularly for the predominately White university student sample, which likely had URM students in the sample.

Empirical Studies on Self-Efficacy and STEM Career Development

Despite the multiple concepts in SCCT, existing empirical research has focused primarily on the explanatory power of self-efficacy toward understanding a range of career development outcomes. As noted in the background literature review, Bean and Eaton's (2001) retention model explains that institutional interactions will have an effect on students' psychological processes, with each process being associated with a particular outcome, ultimately leading to behavioral intentions to persist. In their model, Bean and Eaton (2001) identified three psychological theories that help to explain behavioral intentions: self-efficacy theory, attribution (locus of control) theory, and coping behavioral (approach-avoidance) theory. Although each one of these is a plausible predictor of persistence, self-efficacy has been cited in a variety of literatures as being a specific and significant indicator of individual persistence behaviors (Di Paula & Campbell, 2002). As a widely-studied psychological construct, self-efficacy has been used to specifically understand academic behavior and outcomes (e.g., persistence, achievements, choice in career and majors).

The larger body of empirical research on undergraduate students pursuing STEM degrees supports the predictive power of self-efficacy toward explaining students' career interests and choice of major (Betz & Hackett, 1983; Lent et al., 2001, 2003), academic performance and persistence (Hackett & Betz, 1989; Hackett, Betz, Casas, & Rocha-Singh, 1992; Pajares & Miller, 1994), and future STEM career aspirations (Zeldin et al., 2008). To demonstrate the importance of self-efficacy in college *major choice*, Hackett and Betz (1989) conducted a quantitative study on the relationship between mathematics self-efficacy, mathematical performance and the choice of mathematics-related college majors among undergraduate students attending a four-year university (N=262). Mathematics self-efficacy was measured using the Mathematics Self-Efficacy Scale (MSES) developed by Betz and Hackett (1983), which contains 52 items relevant to the study of mathematics-related self-efficacy. In order to evaluate the self-efficacy and performance relationship at a task-specific level, mathematics performance was measured by students' actual performance on a total of 18 arithmetic, algebra, and geometry math problems. Student background and career choice were assessed by a questionnaire containing a series of questions asking information about mathematics preparation (number of mathematics courses taken in high school) and career plans. Preliminary data analyses showed that both mathematics performance and mathematics self-efficacy were significantly correlated with choosing a mathematics-related major. However, regression analyses showed that mathematics self-efficacy was a stronger predictor of mathematics-related career choice over both the performance and prior achievement variables. The results supported Bandura's (1977, 1982) hypothesis that self-efficacy is a significant mediator of past experiences (previous reported achievement in high school) and performance, and also significantly predicts of future behavioral intentions (Hackett & Betz, 1989). A limitation to this study is that the current or intended college majors of these students were not identified, therefore the results could not differentiate if these students previously had strong intentions to major in STEM-related majors or not. Also, the race/ethnicity of students was not indicated; thus, no results are reported on the relationship between self-efficacy and college major choice among URM students. The only student demographic attribute indicated was gender.

To examine the role of self-efficacy on *academic achievement* in STEM, Hackett and colleagues (1992) conducted a quantitative study on the relationship of academic self-efficacy and academic achievement among a diverse body of undergraduate students (N=197) in engineering and science majors at a four-year university; 51 of these students were URM students. Self-efficacy with regard to engineering and science was operationalized in two ways: occupational self-efficacy (belief in one's ability to successfully complete the degree requirements in an intended STEM major) and academic milestones (belief in one's ability to successfully complete various successive course requirements in a defined STEM major).

Data analyses showed that both occupational and academic milestones self-efficacy measures were significantly and strongly correlated to academic achievement (college GPA measures) with academic milestones self-efficacy bearing a stronger relationship than occupational efficacy. The results for academic milestones self-efficacy in STEM allowed for the study to demonstrate the relationship to performance at a more domain-specific level, which highlights the usefulness of the construct of self-efficacy to examine STEM-related self-efficacy to STEM persistence. However, the authors cautioned that this result could be due to the sample being mostly first- and second-year students, meaning completion-to-degree could not be assessed, and thus academic course completion was used as a proximal measure of persistence. Race/ethnicity was not directly predictive of performance. However, race/ethnicity was a significant predictor of both occupational and academic milestones self-efficacy, with Latino/a students reporting lower academic milestone self-efficacy than White students. The overall finding suggests that academic self-efficacy mediates the effects of prior academic achievement and race/ethnicity on academic achievement. Future research for this type of study requires a much larger sample of students of color to fully examine interactions of race/ethnicity and STEM self-efficacy and related outcomes.

To examine the role of self-efficacy on *persistence* in STEM, Lent, Brown, and Larkin (1984) designed a study to investigate the relationship between self-efficacy beliefs, academic achievement, and persistence among undergraduate students (N=42) in science and engineering majors. Adapting Betz and Hackett's (1981) procedures, Lent and colleagues (1984) developed a list of 15 scientific and technical occupations relevant to their sample and measured the student' self-efficacy (level and strength) with regard to these occupational titles. They conducted a one-year follow-up study and compared academic performance and persistence in the initial self-reported STEM major among students reporting high and low self-efficacy. Results indicated that the level and strength of self-efficacy for educational requirements in these majors were generally related to academic outcomes. Students reporting high-level and high-strength self-efficacy ratings regarding their ability to complete their science and engineering courses achieved higher grades and persisted longer in these majors (assessed one year later) than those with relatively low self-efficacy ratings. Interestingly, although these low/high self-efficacy groups did not differ significantly in their STEM-related course grades, approximately half of the lower self-efficacy rating group did not persist (were not enrolled in a science or engineering major a year later). A limitation of this study is the relatively small sample size (N=42) and restricted generalizability due to the sample of participants being enrolled in an undergraduate career exploration course (Lent & Hackett, 1987).

Limitations of Existing Research on Social Cognitive Career Theory

The preceding overview of SCCT empirical research suggests that the core self-efficacy construct is predictive of a wide range of STEM higher education and career-related outcomes. For example, studies on STEM-related self-efficacy among undergraduate students have shown significant positive relationships between STEM interest and (1) choosing STEM-related majors (e.g., Hackett & Betz, 1989), (2) academic performance in STEM-related courses (e.g., Hackett et al., 1992), and (3) persistence in STEM degree programs (e.g., Lent, Brown, & Larkin, 1984). These empirical studies have found clear links from self-efficacy to persistence and other educational outcomes, but is limited in clarifying *how* self-efficacy either mediates the effects of, or operates *with* other core SCCT constructs as proposed by major theorists (e.g., Bandura, 1977, 1982, 1997; Lent, Brown & Hackett, 1994, 2000, 2002). Therefore, a major drawback in existing SCCT research is that relatively few studies have systematically investigated the theoretical propositions about how self-efficacy operates with other social-cognitive factors to explain higher education and career outcomes. Additionally, there is a need for further research on URM student populations to further clarify how self-efficacy operates with other core SCCT constructs (i.e., outcome expectations, the four social learning antecedents, background status characteristics and proximal environmental contexts) to better explain their career-related persistence and outcomes.

In their college retention model, Bean and Eaton (2001) assert that an individual's behavioral intention to persist is a strong predictor of actual persistence. They further assert that intentions are shaped by beliefs, and beliefs are shaped by experiences. Yet, how students assess their experiences (the cognitive-appraisal process of self-efficacy beliefs) from the various sources within the institutional environment is still not clear from existing self-efficacy research. Furthermore, from the self-efficacy information sources (i.e., social and verbal encouragement, vicarious learning experiences) described in this chapter, the literature indicates that on average, URM undergraduate students may have less access to these sources. For example, verbal and social persuasive communication and evaluative feedback as a source of self-efficacy is most effective to students when the ones who provide this information are viewed as knowledgeable and trustworthy (Bong & Skaalvik, 2003; van Dinther et al., 2011). However, the lack of diversity within STEM faculty may leave URM undergraduate students without adequate support from faculty role models, mentors, and advisors.

A major gap in the existing literature is that other socio-cognitive motivational factors that influence students' self-efficacy, as well as other SCCT constructs, were not explored as part of holistically examining plausible explanations for students' STEM major decisions; achievement of important STEM milestones (e.g., successful course completion); and persistence toward STEM degree completion. Rigorous studies are needed to extend our understandings of socio-cognitive measures that are particularly relevant to investigating URM undergraduate students' persistence in STEM in academic contexts. Limitations in this body of SCCT research and in the higher education research on undergraduate student persistence can be addressed with examinations of how students assess their experiences to arrive at the decision to persist, and specifically, how the four sources of self-efficacy information— along with other socio-cognitive factors— affect persistence decisions for URM undergraduate students in STEM.

Role of Motivation in STEM Persistence among Women of Color: Need for a SCCT Reformulation

Although there is a lack of empirical research on self-efficacy's independent and concurrent (with other socio-cognitive predictors) influence on STEM persistence outcomes, several critical reviews of SCCT support the importance of extending socio-cognitive concepts to better understand STEM career-related interests, goals and outcomes, especially among Women of Color (Byars & Hackett, 1998; Byars-Winston, et al., 2010, Byars-Winston & Foaud, 2008). These critical reviews provide a rich foundation for reformulating basic propositions in SCCT to further clarify pivotal motivational and contextual factors that promote STEM persistence among Women of Color. For example, Byars and Hackett (1998) provide a SCCT conceptual extension showing how socio-cognitive factors may mediate the impact of race/ethnic and gender status, background affordances, and contextual factors on career-related outcomes among Women of Color. In subsequent SCCT reviews, Byars-Winston and colleagues (Byars-Winston, et al., 2010; Byars-Winston & Foaud, 2008) further show how intervening in the academic and career behavior of Women of Color necessitates a deeper understanding of socio-cognitive processes by which contextual and cultural variables exert their influence on career-related outcomes. These studies provide empirical support for a reformulation of SCCT to advance research on key socio-cognitive factors that promote success among underrepresented students. This dissertation reformulates SCCT to increase understanding of the motivational mechanisms that promote STEM persistence among Women of Color in STEM academic contexts.

Expectancy-Value Theory and Related Motivation Models

Building on insights from ***expectancy-value theory*** (EVT**),** this dissertation: (1) reformulates SCCT to better understand STEM career development among Women of Color, and (2) employs this reformulated SCCT to investigate the importance of self-efficacy and other pivotal socio-cognitive motivation predictors for understanding STEM persistence among Women of Color, specifically within strengths-based pipeline intervention contexts. Therefore, this dissertation goes beyond the traditional SCCT focus on self-efficacy to provide deeper insight into multiple socio-cognitive motivation predictors of STEM persistence plans among Women of Color who must often overcome systemic barriers associated with the intersection of both race and gender.

My SCCT reformulation builds on a range of EVT models (e.g., Eccles, 1983, 1987), but expectancy-value models guiding organizational, educational, and career development research are especially relevant to understanding motivation and persistence among Women of Color in undergraduate STEM intervention settings (Bowman, 1977; Eccles & Wigfield, 2002; Feldman, 1999; Hackett, 1997; Lawler, 1994; Mitchell, 1982). These expectancy-value models and related empirical research further clarify how self-efficacy operates together with outcome expectancies, and individuals' socio-cognitive appraisals of their STEM talents and STEM intervention-based experiences to motivate STEM persistence plans. For example, EVT and research in organizational settings suggests that research mentors (supervisors) and peers (co-workers) within STEM intervention settings may be especially important to student motivation and persistence (e.g. Lawler, 1994). My SCCT reformulation also builds on principles from EVT to incorporate insights from a related role-strain model to systematically consider how socio-cognitive appraisals of contextual barriers and supports might impact STEM persistence plans among Women of Color (e.g., Bowman, 2006, 2012; Burt, Williams, & Smith, 2018).

Insights from expectancy-value theory. Traditional SCCT builds on EVT, but places major emphasis on the pivotal explanatory power of ***self-efficacy beliefs*** or expectations (e.g., Bandura, 1986; Lent, Brown, & Hackett, 1994). However, research on EVT in social psychology also reveals that self-efficacy systematically combines with ***outcome expectancies*** and other ***socio-cognitive factors*** to better explain motivation and persistence (e.g. Bowman, 1977; Eccles & Wigfield, 2002; Feather, 1982; Lawler, 1997). Guided by these insights, the SCCT reformulation in this dissertation goes beyond self-efficacy to also consider several other socio-cognitive motivational factors including ***outcome expectancies***, ***intrinsic self-identity***, and social-cognitive appraisals of ***proximal intervention experiences*** as well as more ***distal socio-cultural barriers*** and ***supports***.

Expectancy-value theory has deep roots in social psychology, but has been widely applied in many different fields including organizational studies, education, public health, communications sciences, and economics (Bandura, 1977; 1987; Bowman, 1977; 2012; Feather, 1982; Fishbein & Ajzen, 1975; Lawler, 1994; Mitchell, 1982). Although the basic theoretical model has been adapted with unique meaning and implications in various fields, they all share the basic expectancy-value proposition that a person's expectations ***as well as their values or beliefs*** are powerful predictors of motivation and subsequent behavior in a broad range of situations. EVT builds off the work of John Atkinson (e.g., Atkinson, 1957; 1966) who developed an expectancy-value model to examine how expectancies and values influence achievement motivation. Within the field of education, Jacquelynne Eccles (e.g., Eccles, 1983) further adapted this expectancy-value model with a particular emphasis on motivation and achievement among middle school students (Eccles, 1983; Eccles & Wigfield, 2002). According to Eccles's model, individuals' performance and choice of achievement tasks are largely predicted by their expectations for success (e.g., self-efficacy) and personal values (e.g., intrinsic-value) they ascribe to the task (Battle & Wigfield, 2003). Success expectancy refers to a sense of competence an individual has in his or her ability to do well in a task while values refer to how salient the individual regards the task (Battle & Wigfield, 2003; Lauermann, Tsai, & Eccles, 2017). Related empirical research supports a predictive link of the interaction of expectancies and values to positive academic outcomes (Eccles et al., 1983; Eccles & Wigfield, 2002; Lent, Brown, & Hackett, 2002).

Eccles (1987) later extended this model to examine students' processes of making career choices, proposing that success expectancies and personal values are leading determinants of one's career choice (Battle & Wigfield, 2003). Battle and Wigfield (2003) used this extended model to examine college women's intention to attend graduate school based on their valuing of advanced academic pursuits. Their study found that the opportunity to fulfill intrinsic needs for personal important life goals, enjoyment and usefulness was the strongest predictor of intentions to attend graduate school. Jones, Paretti, Hein, and Knott (2010) also used this model to examine the relationship among expectancy- and value-related constructs for men and women first-year engineering students. Expectancy-related measures included engineering self-efficacy and expectancy for success in engineering, while value-related measures included identification with engineering and beliefs related to engineering interest, importance and usefulness. Their study found that expectancies significantly predicted academic achievement (i.e., grade point average) and value-related constructs (i.e., extrinsic utility value, intrinsic interest, and identification) significantly predicted career plans, for both men and women.

Success expectancy and self-appraisals. According to Eccles and colleagues (1983), success expectancies are conceptualized as beliefs and judgments individuals have about whether they can accomplish a particular action (Carberry, 2010). The expectancies an individual have are assumed to influence achievement choice as well as performance, effort and persistence (Wigfield, & Eccles, 2000). These expectations are tied to self-appraisals such as self-concept, self-identity and self-efficacy. Self-identity is a broader concept that involves one's general beliefs about their own natural talents, abilities, and skills (e.g., Rosenberg, 1965). Self-efficacy is similar, defined by Bandura (1986) as a person's judgment of his or her ability to perform a task within a specific domain (B. Jones et al., 2010).

Intrinsic value, task value and outcome expectancies. Going beyond academic self-efficacy *(e.g., "Am I capable of successful academic performance?")*. Eccles's EVT model (Eccles, 1983), emphasizes the importance of intrinsic task value and outcome expectancies as the motivation that allows an individual to answer the question, *"Do I want to do this activity and why?"* (Wigfield & Cambria, 2010). Within Eccles's (1983, 1987) model, subjective task value is the value an individual ascribes to a particular endeavour (Eccles, 2009; Wigfield & Eccles, 2000). The broader subjective task-value construct considers four subcategories of task values: 1) attainment value (importance to one's identity), 2) intrinsic value (interest, enjoyment), 3) utility value (usefulness toward one's future goals), and 4) perceived costs (perceived drawbacks) (Eccles, 1983; Eccles, 2009; Perez, Cromely, & Kaplan, 2014; Wigfield, Tonks, & Kluada, 2009). Both attainment value and instrinsic value have been shown to be strongly correlated (Deci, 1972a; 1972b; Deci, Koestner, & Ryan, 1999).These value constructs have been linked to student intrinsic motivation and persistence (Simens, Dewitte, & Lens, 2004).

Cost appraisals and intervention. *Cost appraisals* have been rather limited in empirical research, and very few expectancy-value studies have adequately considered how social-cognitive appraisals of systemic barriers facing underrepresented students may impact their extrinsic motivation, stress and coping related to achievement strivings. However, studies have shown that systemic barriers, represented by status characteristics (e.g., race/ethnicity, gender, family income) may affect achievement outcomes ***both*** directly and indirectly through these cost expectations and appraised values (Bowman, 1977; Eccles, 1983; Eccles & Wigfield, 2002). Research also suggests that socio-cognitive appraisals of systemic barriers can help to better understand racial and gender differences in achievement-related motivation (Bowman, 1977; Gurin & Epps, 1974; Jacobs, Lanza, Osgood, Eccles, Whitfield, 2002). For example, an expectancy-value study by Bowman (1977) demonstrated the importance of ***intrinsic***, ***organizational,*** and ***social mobility goals*** in the motivation and achievement of Black students faced with systemic barriers.

EVT constructs have also been used in pipeline intervention programs that aim to transform students' motivational beliefs. These interventions are able to promote motivation by increasing various expectancies (Blackwell, Trzesniewski, & Dweck, 2007), instrumental values (Hulleman, Schrager, Bodmann, & Harackiewicz, 2010), and decrease cost with perceived barriers (Ramirez, & Beilock, 2011). Such value-focused interventions not only target motivation, but also enhance overall academic achievement (Good, Aronson, & Inzlicht, 2003; Hulleman & Harackiewicz, 2009).

Self-Efficacy and Outcome Expectancies. As discussed earlier, traditional SCCT extrapolated from Bandura's model to place an emphasis on the explanatory power of self- efficacy, while underplaying the importance of outcome expectancies (e.g., Bandura, 1986; Lent, Brown, & Hackett, 1994). However, a substantial body of EVT-driven research in organizations and other settings has demonstrated the importance of ***outcome expectancies*** in explaining achievement-related attitudes, motivation and behaviors (Ajzen, 1988; Fishbein & Ajzen, 1975; Lawler, 1994; Mitchell, 1982). Such EVT and related empirical studies have demonstrated the powerful effects of outcome expectancies on motivation and behavior in work organizations and a broad range of other fields including education, health, communications, marketing, and economics.

EVT-driven research in organizational settings has further clarified how both intrinsic and extrinsic ***outcome expectancies*** combine with self-efficacy to better explain motivation and successful behavior in complex social situations (e.g., Lawler, 1994; Mitchell, 1981). In addition to STEM self-efficacy, EVT and related research in organizational settings provide substantial support for four related propositions regarding interrelationships between a person's ***STEM motivation, valued outcomes, outcome expectancies, and persistence:***

1. **Valued Outcome:** STEM motivation depends on a range of personally-valued outcomes — both intrinsic and extrinsic;
2. **Outcome Expectancies:** STEM motivation is increased by outcome beliefs that one's STEM strivings will lead to valued intrinsic and extrinsic outcomes;
3. **Outcome Expectancies Interact with Self-Efficacy:** STEM motivation depends on the interaction of both outcome expectancies and STEM self-efficacy (i.e., beliefs that one is capable of STEM success);

4. **STEM Motivation:** Outcome expectancies and self-efficacy directly increase STEM motivation indicators (persistence effort, intention, plans), and in turn, influence actual STEM persistence;
5. **STEM Persistence:** Actual STEM persistence not only depends on STEM motivation, but also STEM academic preparation and opportunity (objective barriers and supports).

STEM Motivation (*Effort, Intentions and Plans*) and Actual Persistence

As an EVT, the Theory of Planned Behavior (TPB) and related empirical evidence support the importance of short-term STEM persistence plans or intentions in predicting longer-term STEM persistence behaviors (e.g., Ajzen, 1988). TPB posits that a student's highly-valued STEM outcome expectancies directly produce positive STEM attitudes and motivation (persistence intentions and plans), which in turn, influence actual STEM persistence. Hence, a student's outcome expectancy beliefs that STEM achievement behavior is a pathway to highly-valued goals motivate STEM behavioral plans, persistence, and career success. TPB also states that the result of expectancy-value is derived from one's expectancy beliefs and values toward their intended academic and career goals.

Consistent with the TPB, this dissertation focuses on the importance of better understanding the relationship between short-term persistence plans and longer-term STEM persistence outcomes for a more meaningful analysis of STEM motivation among Women of Color in STEM higher education and within STEM pipeline interventions. A growing body of related empirical evidence demonstrates how such persistence plans or intentions are critical determinants of actual persistence behaviors and outcomes (Ajzen, 1991; Cabrera et al. 1993; Doll & Ajzen, 1992; Foltz, L. Foltz, C. & Kirschmann 2015). By clarifying the pivotal effects of short-term intentions on longer-term behaviors, the TPB supports the importance of better understanding short-term persistence plans in STEM persistence research. Retention theory and research in higher education has also supported the importance of short-term plans to understanding more distal persistence outcomes. For example, empirical investigations of student attrition models (e.g., Bean & Metzner, 1985; Tinto, 1975, 1987, 1993) suggest that one's intention to persist explain a significant degree of the variance in persistence behaviors (Chartrand, 1992; Sandier, 2000). Therefore, longer-term STEM persistence outcomes among URM undergraduates, especially within exemplary interventions, may depend on strategies and mechanisms that reinforce *short-term plans* to persist in STEM majors, pursue advanced STEM studies, and STEM research careers.

Insights from a Role Strain and Adaptation Model

My SCCT reformulation also builds on a *role strain and adaptation* (RSA) model to provide deeper insight into the role of contextual barriers and supports in STEM persistence among Women of Color (e.g., Bowman, 1977, 1989, 2006, 2012, Mendenhall, Zang, & Bowman, 2012). Building on principles from EVT, this multilevel RSA model provides a systematic basis to better understand how self-efficacy, outcome expectancies, and pipeline intervention experiences *operate with* broader socio-cultural contextual factors to impact STEM persistence among Women of Color (Bernheardt, 1997; Bowman, 1977, 2012; Feldman, 1999). This strengths-based social-psychological approach focuses on two pivotal concepts to explain student persistence — role strain and role adaptation. Student *role strain* refers to objective barriers (multilevel racial, financial, academic) and cognitive appraisals of such barriers (role discouragement, self-blame, stress, etc.) that impede persistence and success. Despite role strain, *role adaptation* is the related process through which students' resiliency helps them to mobilize multilevel strengths (personal, intervention-based, socio-cultural, supportive policy, etc.) to promote motivation, persistence, and success.

Guided by strengths-based principles, the RSA further clarifies the operation of multilevel, diversity, and pipeline issues in motivation and achievement (Bowman, 2006, 2012). Consistent with ecological studies, this comprehensive RSA model emphasizes the importance of better understanding multilevel barriers and strengths at the personal, intervention, and broader socio-cultural levels that may impact STEM persistence. A better understanding of how *socio-cultural barriers* and *supports* impact STEM persistence is especially important for Women of Color and other URM students who must navigate systemic barriers associated with the complex intersection of race, gender and social class diversity. Related quantitative, qualitative, and critical studies on STEM persistence issues among URM students supports inquiry on Women of Color in pipeline interventions (Burt, Williams, & Smith, 2018; Williams, 2014; Williams, Burt, & Hilton, 2016). For example, guided by this RSA approach, a recent quantitative study using national datasets supported the importance of both *socio-cultural barriers* and *strengths* on math achievement of both students of color and girls of different racial/ethnic backgrounds (Williams, Burt, & Hilton, 2016). Additionally, a recent qualitative study employing this RSA approach suggests that multilevel supports are necessary to address racialized barriers at the policy and interpersonal levels that impede persistence among Black males in engineering graduate programs (Burt, Williams, & Smith, 2018).

SCCT Reformulation: Conceptual Model and Propositions

Building on insights from both expectancy-value and role strain theories, Figure 3.2 presents a conceptual model showing my SCCT reformulation. This model can guide future research on pivotal mechanisms that facilitate and undermine successful STEM outcomes among underrepresented groups. Despite the power of SCCT to help explain STEM-related outcomes such as persistence, the major concepts may operate in particular ways to among Women of Color and other underrepresented groups. This reformulated conceptual model acknowledges the empirical evidence from summative evaluation studies that increasingly supports the effectiveness of strengths-based career pipeline interventions in promoting STEM persistence and related career success (e.g., Hrabowski et al., 2002; Maton & Hrabowski, 2004). Related formative evaluation studies have also shown that these strengths-based interventions are characterized by multiple components including strength-based recruitment, comprehensive support systems, institutional commitment, and related socio-cognitive theoretical constructs (e.g., Carter, Mandell, & Maton, 2009; Maton et al., 2016; May & Chubin, 2003).

As depicted in Figure 3.2, my SCCT reformulation focuses on two sets of pivotal mediating mechanisms that help to explain the effectiveness of strengths-based career pipeline interventions. Hence, a central tenet is that the multiple components in strengths-based career pipeline interventions: (a) provide strong intervention-based sources of self-efficacy which, in turn, (b) increase socio-cognitive motivation and successful STEM outcomes. In addition, this SCCT reformulation also posits that socio-cultural contextual factors directly impact STEM persistence outcomes. A better understanding of how pivotal socio-cognitive beliefs operate with contextual factors may be especially critical for Women of Color pursuing STEM careers who may require unique socio-cultural supports to overcome systemic barriers within STEM academic contexts (Byars & Hackett, 1998; Hrabowski, Maton, Green, & Grief, 2002; Seymour & Hewitt, 1997). These mechanisms may also be critical for Women of Color who bring a unique set of status characteristics (race, ethnicity, gender), natural talents and interests to STEM fields.

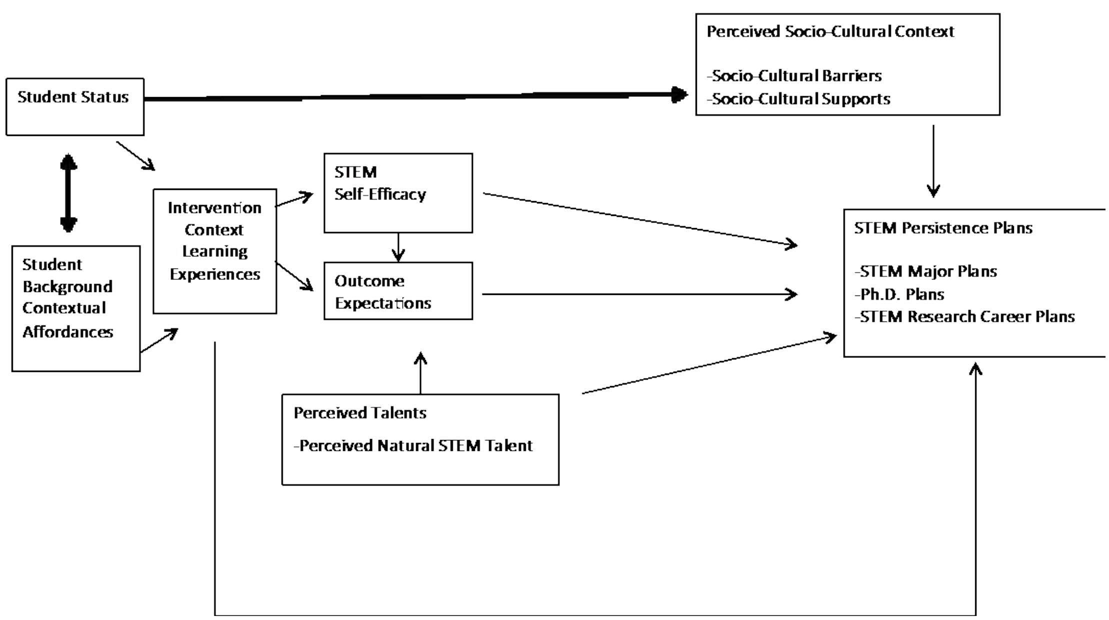


Figure 3.2: Social Cognitive Career Theory Reformulation - A conceptual model.

As outlined in Figure 3.2, my SCCT reformulation provides the foundation for *four interrelated* ***propositions*** to guide future research on socio-cognitive motivation and STEM persistence plans among Women of Color at various stages in the higher education pipeline. The four propositions are as follows:

1) In addition to a student's ***self-efficacy***, various ***outcome expectancies*** are also pivotal socio-cognitive motivation predictors of STEM persistence plans;
2) a student's perceptions of ***intervention-based experiences***—specifically verbal/social persuasion and vicarious learning—reinforce self-efficacy, outcome expectancies, and STEM persistence plans;
3) a student's self-appraisal of having ***natural STEM talents*** reinforces their intrinsic outcome expectancies and STEM persistence plans; and,
4) a student's perceptions of the ***socio-cultural context*** — including barriers and supports — are significant socio-cognitive motivation predictors of STEM persistence plans.

Major Research Questions and Hypotheses

The major goal of this dissertation is to *reformulate* social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994) and investigate several hypotheses which—by going beyond a narrow focus on self-efficacy—provide a deeper understanding of socio-cognitive motivation predictors of STEM persistence plans among Women of Color during the undergraduate-to-graduate studies transition. My SCCT reformulation helps to better clarify how pivotal socio-cognitive motivational and contextual mechanisms operate within STEM pipeline interventions for underrepresented undergraduate students designed to promote STEM major persistence, Ph.D. studies, and faculty research careers. More specifically, this dissertation reformulates SCCT propositions to investigate several critical STEM career-related issues among Women of Color, who face systemic barriers associated with the complex intersection of both race and gender. Guided by the major propositions in my SCCT reformulation, I investigate six research questions and related hypotheses. For each of the six research questions, the associated testable research hypotheses specify the expected findings based on existing social-cognitive theory and empirical research. My research questions and related hypotheses are:

Q1) How do STEM-related socio-cognitive motivational predictors (self-efficacy and outcome expectations) predict STEM persistence among Women of Color?

Hypothesis 1a: STEM self-efficacy and outcome expectancies have separate effects on STEM persistence plans.

Hypothesis 1b: STEM self-efficacy and outcome expectancies also have significant *interaction effects* on STEM persistence plans.

Q2) How do STEM *intervention-based* experiences (mentor encouragement and vicarious peer learning) and *prior learning* experiences (academic mastery and emotional state) predict STEM self-efficacy and outcome expectations among Women of Color?

Hypothesis 2a: Intervention-based experiences and prior learning experiences are significantly related to *STEM self-efficacy* among Women of Color.

Hypothesis 2b: Intervention-based experiences and prior learning experiences are significantly related to *various outcome expectancies* among Women of Color.

Q3) How do intervention-based experiences, prior learning experiences, and socio-cognitive motivation predictors collectively predict STEM persistence plans among Women of Color?

Hypothesis 3a: Together, intervention-based and prior learning experiences, and socio-cognitive motivation predictors explain significant variance in STEM persistence plans among Women of Color.

Hypothesis 3b: Specific societal-goal expectancies operate independently of other socio-cognitive motivation predictors, intervention-based experiences, and prior learning experiences among Women of Color in STEM majors.

Q4) How do Women of Color's own perceived STEM talents predict their STEM self-efficacy, outcome expectations, and STEM persistence plans?

Hypothesis 4a: Perceived STEM Talents enhance STEM persistence plans among Women of Color;

Hypothesis 4b: Perceived STEM Talent should have a stronger relationship to intrinsic-goal expectancy than other traditional socio-cognitive motivation predictors among Women of Color;

Q5) How do perceived socio-cultural context predictors (role-strain barriers and adaptive role supports) predict STEM persistence plans among Women of Color?

Hypothesis: Role-strain barriers and adaptive-role supports — both subjective and objective — predict STEM persistence plans among

Women of Color.

Q6) How do multiple socio-cognitive motivation predictors, together with traditional predictors of persistence, help to further explain STEM persistence plans among Women of Color?

Hypothesis 6a: In addition to STEM self-efficacy, multiple socio-cognitive predictors help to further explain STEM persistence plans among Women of Color.

Hypothesis 6b: Multiple STEM socio-cognitive motivation predictors, along with traditional predictors of persistence, help to further explain STEM persistence plans for Women of Color.

Chapter 4 Research Methods

This study investigated the hypothesized relationships between socio-cognitive motivation predictors and STEM persistence plans among undergraduate Women of Color in STEM majors. This chapter begins with a presentation of the research setting, sample, study design and the study rationale. Afterwards, I describe the measures used to operationalize the constructs in my model. Finally, I discuss the data analysis procedures employed to address my research questions and related hypotheses.

Survey Research Design

This dissertation is a secondary analysis of a subset of longitudinal survey data collected as a component of a broader mixed-method study funded by the National Institute of Health's National Institute of General Medical Sciences (NIH-NIGMS) (Award Number R01GM088750). The overarching study was titled "A Multimethod Study of Exemplary Research Opportunity Interventions", and the principal investigators were Dr. Phillip J. Bowman and Dr. Angela Ebreo at The University of Michigan. The *panel survey design* for this study involved survey data collection at four time points from undergraduate students who *applied* to the Big Ten Academic Alliance Summer Research Opportunities Program (BTAA-SROP). To address the major research questions, panel survey data were collected from the BTAA-SROP applicants before the intensive 8-week summer interventions in Summer 2011 and during the subsequent semesters (Fall 2011, Spring 2012, Summer 2012).

Research Setting

As the *research setting* for the present study, the BTAA-SROP provides competitive pipeline intervention activities at 14 major research universities for high performing and highly motivated undergraduates from diverse backgrounds. A primary BTAA-SROP goal is to promote advanced Ph.D. studies and faculty research careers among historically underrepresented students. Students of Color and others selected for the exemplary BTAA-SROP are provided with a faculty mentor who supervises a formal research project, as well as multiple strengths-based intervention components including a strong staff and peer support system, graduate school preparation, and academic career development programming (e.g., Bailey, 2014). Although the parent study includes multiple cohorts of BTAA-SROP applicants, this dissertation study focuses on a single cohort (2011)—students who applied to participate during the summer of 2011 and agreed to participate in the longitudinal survey study.

The BTAA-SROP was initiated in 1986 and is currently active at 14 Big Ten Academic Alliance institutions, which is an academic consortium of major research universities. Since its inception, the *exemplary* BTAA-SROP has served over 12,000 students and has a primary diversity objective to increase the number of undergraduates from underrepresented groups who pursue Ph.D. studies and faculty research careers. The BTAA-SROP data for this dissertation study came from surveys of students who applied to at least one of the 14 BTAA-affiliated institutions for the 2011 summer programming year. The following BTAA institutions participated in the study: University of Illinois at Urbana – Champaign, University of Iowa, University of Michigan, Michigan State University, University of Minnesota, Northwestern University, The Ohio State University, Pennsylvania State University, Purdue University, and the University of Wisconsin at Madison. In addition, regional campuses, (e.g., University of Illinois at Chicago, and University of Wisconsin at Milwaukee) were invited to participate in the study. Historically (up until the fall of 2012), both of these regional campuses had been included in the activities of the BTAA-SROP as "BTAA affiliated" institutions. Due to the urban nature of these two campuses, the principal investigators believed that their inclusion in the study provides additional insights into the generalizability of findings related to undergraduate summer research programs.

BTAA-SROP primarily targets juniors and rising seniors to introduce the research enterprise and promote success in graduate studies and faculty research careers. It is an 8-10 week residential program, which takes place during the summer term. Participants receive a stipend, spend 40 hours per week working with a faculty research mentor on a research project, and actively participate in a comprehensive set of activities in preparation for advanced graduate studies. In addition to academic strengths, participants are selected with a holistic focus on personal strengths including strong motivation to pursue a Ph.D. and faculty research careers rather than those most interested in pursuing terminal professional degrees which typically prepare recipients for non-academic pathways (e.g., law degrees). BTAA-SROP's long-term goal is to serve as a pathway for underrepresented students toward graduate studies and ultimately, faculty research careers.

Research Sample and Data Collection

The sample for this study(N=179), Women of Color (Black/African American and Hispanic American), includes: (1) Women of Color who applied and participated in the BTAA-SROP in Summer 2011, (2) Women of Color who applied to the BTAA-SROP, but participated in a similar SROP-type summer undergraduate research program in Summer 2011, and (3) Women of Color who applied to the BTAA-SROP, but did not participate in BTAA-SROP nor a similar program in Summer 2011, for various reasons. All study participants were college undergraduate STEM major students who were at least 18 years old at the beginning of the study (Table 4.1 presents a summary of selected education and socio-demographic characteristics of the study sample.)

Panel survey data were collected through a collaboration between the BTAA, BTAA-SROP host campuses and the Diversity Research & Policy Program—a research team at the University of Michigan. This study utilizes data collected from four time wave: one before, and three time following the multi-week BTAA-SROP interventions. Specifically, the first wave occurred during the summer of 2011, prior to the summer research programming (Time 1). The second wave occurred during the 2011 fall term following the summer research programming (Time 2). After completing the 2011 fall term, students were surveyed during the spring of 2012, (Time 3). Finally, the fourth wave of data collection occurred during the summer of 2012 (Time 4).

This panel survey study utilized a set of carefully designed questionnaires that were administered to students using various mediums – hardcopy surveys by mail, web surveys, and phone interview surveys. These various data collection modes allowed for the utility of different venues for obtaining information based upon which approach was best suited for the various types of questions being asked. Survey data from the broader study is appropriate for the current study because the data collected include scales that operationalize the major constructs in my SCCT reformulation, and also allowed me to explore hypothesized relationships within my the sample of interest (Babbie, 1990). My dissertation analyses were designed to investigate socio-cognitive motivation and STEM persistence plans among undergraduate Women of Color STEM majors.

Education status and socio-demographic background. Table 4.1 presents a summary of selected education and socio-demographic characteristics for my study sample, undergraduate Women of Color (African American and Hispanic American women) in STEM majors. In terms of education status, a higher percentage of participants indicated Biomedical/Behavioral Sciences and Social Sciences as their current undergraduate major, while a lower percentage indicated "Other Basic or Applied Sciences: as their major (82% versus 18%). More of these students indicated that they participated in either BTAA-SROP or a similar summer research program compared to no summer research programming (80% versus 20%). My study participants were mostly in their junior or senior years in college (95%) and had strong academic grades. In regards to socio-demographic background, the study sample was mostly of traditional college age (20-23 years of age). A higher percentage reported coming from lowerincomes versus higher-income family backgrounds (67% versus 37%), and attending a university comprised of half or mostly their racial/ethnic group versus less than half of their racial/ethnic group (59% versus 41%). Slightly more Women of Color indicated their mother's education level at a four-year degree or higher (51%), although there was a considerable percentage of first-generation Women of Color (49%). Comparisons between the Women of Color current study sample and other relevant sub-samples can be found in Appendix D.

Table 4.1 Educational Status and Demographic Background of the Women of Color Study Sample (N=179)

Variable	Women of Color[a] (%)
I. Education Status	
Undergraduate STEM Major	
Biomedical/Behavioral Sciences	76 (42%)
Other Basic or Applied Sciences (e.g., Physics, Engineering)	32 (18%)
Social Science (e.g., Psychology, Economics)	71 (40%)
Total	179 (100%)
Summer Research Experience	
CIC-SROP	96 (66%)
CIC-SROP-like	20 (14%)
No Summer Research Experience	29 (20%)
Total	145 (100%)
Grades (Cum. GPA)	
A (GPA=4.0)	24 (20%)
B (GPA=3.9 - 3.0)	95 (77%)
C (GPA=2.9 - 2.3)	4 (3%)
Total	123 (100%)
Student Year	
Senior	88 (69%)
Junior	33 (26%)
Sophomore	6 (5%)
Freshman	0 (0%)
Total	127 (100%)
II. Socio-Demographic Background	
Race/Ethnicity	
Black/African-American	125 (70%)
Hispanic/Latina	54 (30%)
Total	179 (100%)
Age	
18-19 yrs.	11 (6%)
20-23 yrs.	147 (83%)
24 yrs. and over	20 (11%)
Total	178 (100%)
Low Income (Pell Grant Eligibility)	
Yes	77 (63%)
No	46 (37%)
Total	123 (100%)
Mother's Educational Background	
Less than four year degree (e.g., BA, BS)	59 (49%)
Four year degree (e.g., BA, BS)	32 (27%)
Masters Degree (e.g., MA, MS) or higher (e.g., MD, PhD)	29 (24%)
Total	120 (100%)
Racial/Ethnic Majority Campus[b]	
Half or Mostly racial/ethnic group	71 (59%)
Mostly other racial/ethnic groups	50 (41%)
Total	121 (100%)

Notes. [a]Only STEM majors included in this analysis using the National Science Foundation (NSF) definition.
[b]Student's home campus.

Operational Definitions of Model Constructs

Consistent with my Reformulated Socio-Cognitive Career Model (RSCCM), the measures for the STEM persistence plan variables are presented, followed by the measures for the socio-cognitive motivation predictors and other major research variables. I then describe the multiple regression data analysis procedures employed to investigate each research question and related hypotheses. Guided by my RSCCM *conceptual model* developed in the prior chapter Figure 4.1 highlights a related multiple regression *analytic model* which goes beyond the narrow focus on self-efficacy to explore the relationship between multiple socio-cognitive motivation predictors and STEM persistence plans. Additional information about the specific survey items used to operationalize each of the major research constructs can be found in Appendix B. Appendix C included related information on coding strategies for my major research variables.

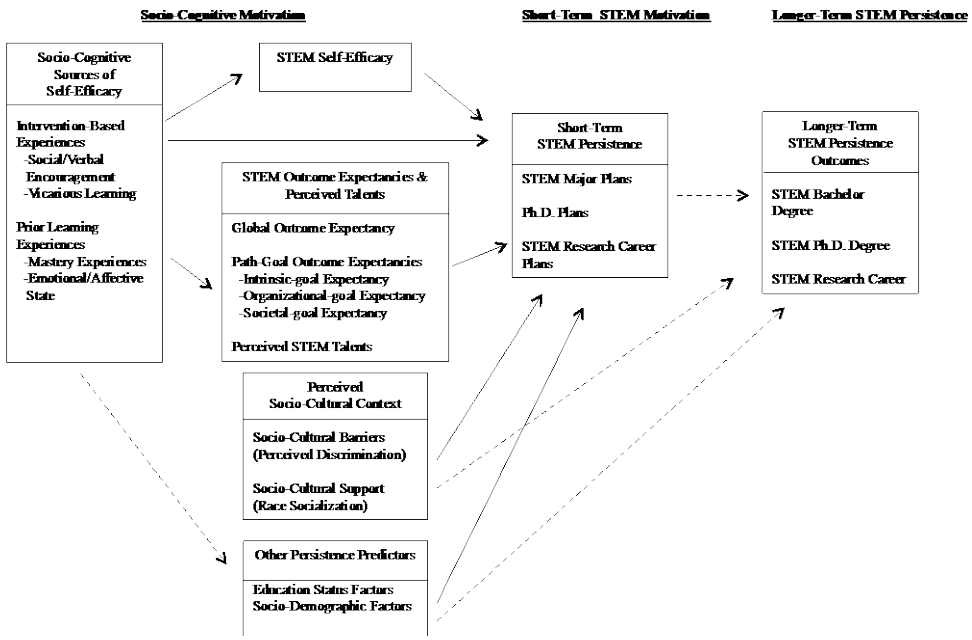


Figure 4.1. RSCCM Analytic Model

Major dependent variables: STEM persistence plans. As previously discussed, the Theory of Planned Behavior (e.g., Ajzen, 1988) supports the importance of short-term STEM persistence plans or intentions as pivotal *motivational* constructs helpful to explain longer-term STEM persistence behaviors. The theory posits that actual behavioral outcomes (e.g., persistence) are *motivated* behavioral intentions (e.g., plans and efforts to persist) to perform the behavior in question (Doll & Ajzen, 1992; L. Foltz, C. Foltz, & Kirschmann, 2015). Three indicators of STEM persistence plans were utilized in this study as pivotal persistence *motivation mechanisms* for Women of Color in STEM majors — *STEM Major Plans, Ph.D. Plans, and STEM Research Career Plans.* More specifically, at Time 3, students were asked to report the degree of certainty that they would complete their undergraduate major in STEM, pursue a Ph.D. degree, and pursue a research career in STEM. Responses were measured on a 5-point scale ranging from 1= *completely certain I will not* to 5 = *completely certain I will.* On the original measures, lower scores indicated a higher degree of certainty of each STEM persistence plan. The items were recoded so higher values would indicate greater certainty. Similar to other Likert-type scales, this type of 5-point subjective probability item can be treated as a continuous variable in regression analyses (e.g., Johnson & Creech, 1983; Zumbo & Zimmerman, 1993). Each of these items provides some information about students' intentions to complete their STEM undergraduate degree, pursue an advanced Ph.D. degree, and to pursue a research career in a STEM field, respectively.

Major independent/predictor variables. This research employs measures from established scales to represent constructs in the RSCCM that are prevalent in existing literature. When no such standard existed, I developed new measures using appropriate psychometric techniques. For example, no standard scales exist for STEM self-efficacy. Accordingly, a new measure was derived to operationalize this construct. Additionally, some existing scales were modified for increased conceptual clarity. Information about the development of the new and established measures is in the following sections. Appendix B provides detail on all predictor variables and developed scales. Table 4.2 presents the time points during which data were collected for each measure.

Table 4.2 Time Table of Independent Measures

Independent Variable	**Time 1**	**Time 2**	**Time 3**	**Time 4**
Status Characteristics	X			
Undergraduate Major (STEM, non-STEM)	X			
Multidimensional STEM Self-Efficacy	X			
STEM Outcome Expectations & Perceived Talents				
Global Outcome Expectancy	X			
Path-Goal Outcome Expectancies -Intrinsic-Goal Expectancy	X			
-Organizational-Goal Expectancy	X			
-Societal-Goal Expectancy	X			
Perceived STEM/Natural Talent	X			
Socio-Cognitive Sources of Self-Efficacy				
Intervention-Based Experiences - STEM Social/Verbal Encouragement (Mentors)		X		
- Vicarious Learning (Peers)		X		
Prior Learning Experiences -Academic Mastery (Cum. GPA)	X			
-Student Emotional State (CESD Depression)		X		
Socio-Cultural Context				
Subjective Barriers (Perceived Discrimination)				X
Objective Barriers (Income/Pell Grant Eligibility)	X			
Subjective Support (Racial Socialization)				X
Objective Support (Racial Campus Diversity)	X			
Other Persistence Predictors				

Education Status - Undergraduate STEM Major (Discipline)	X			
-Summer Research Experience	X			
-Grades (Cum GPA – A, B, or C)	X			
-Student Year	X			
Socio-Demographic Factors -Race/Ethnicity	X			
-Age	X			
-Mother's Educational Background	X			

Student status characteristics. Gender and race/ethnicity are the major policy-relevant socio-demographic status characteristics focused on in this study. Gender was measured as a dichotomous variable (1=male, 2=female). In accordance with standard racial/ethnic U.S. Census classifications in the United States, students were asked two questions regarding their race and ethnicity. The first question asked participants, "Are you of Hispanic, Latino, or Spanish origin?" The response options were: 1=Yes and 2=No. The second question asked participants, "With which racial/ethnic/cultural background do you primarily identify?" The response options were: 1=African American/ Black/ Negro; 2=American Indian or Alaskan Native; 3=Asian American; 4=Native Hawaiian/Other Pacific Islander; 5=White or Caucasian; and 6=Other. According to conventional census classifications to distinguish African American and Hispanic students, responses from the first question were used to distinguish among students who identified as African American/Black/Negro, American Indian/Alaskan Native, Asian American, and Native Hawaiian/Other Pacific Islander. Students who identified as

“Hispanic” in the first question and “Other” in the second were coded as Hispanic/Latino in this study (Williams, 2014). If students identified as “Hispanic” and the first question and either one of the aforementioned racial/ethnic/cultural backgrounds (e.g., 1= African American/ Black/ Negro) for the second question, they were coded as that self-indicated racial/ethnic/cultural background (e.g., if student answered “Yes” to Hispanic, Latino, or Spanish origin and indicated African American/ Black/ Negro for racial/ethnic/cultural background, student was coded as African American/ Black/ Negro). Once the respondent’s racial/ethnic/cultural group was identified, a categorical variable was created to identify traditionally underrepresented students of color as mostly categorized in STEM literature: 0=Other, 1=African American, Black, 2= American Indian or Alaskan Native, 3=Asian American, 4= Native Hawaiian/Other Pacific Islander, 5=White, Caucasian, and 6= Hispanic/Latino (Williams, 2014). For the purpose of this study, a third dichotomous variable was created to identify African American/Black and Hispanic/Latino women.

Undergraduate major. A measure for students’ college major is also included in this study. Students were asked to select the field most related to their major among the following options: Biomedical/Behavioral Sciences; Other Basic or Applied Sciences (e.g., Physics, Engineering); Social Sciences (e.g., Psychology, Economics); Creative Arts (e.g. Theater, Art, Dance, Film); and I have not yet chosen a college major. STEM major was coded as a dichotomous variable where student-identified major in the Biomedical/Behavioral Sciences, Other Basic or Applied Sciences, and Social Sciences were considered STEM majors (1=STEM major), per the National Science Foundation

(NSF) (Gonzalez & Kuenzi, 2012), and all other reported majors were considered non-STEM majors (0=non-STEM major).

Multidimensional STEM self-efficacy. Self- efficacy is defined as one's beliefs in their "capabilities to organize and execute the courses of action required to produce given attainments", (Bandura, 1997, p. 3). The Multidimensional STEM Self-Efficacy Scale employed in this study consists of 18-items that tap a person's beliefs that they are capable of executing the *academic, research,* and *career-related* actions necessary for a successful STEM research career. More specifically, the Multidimensional STEM Self-Efficacy Scale consists of items to tap a person's belief about their ability to execute these three core dimensions of STEM research career competence — *STEM academic self-efficacy* (7 items), *STEM research self-efficacy* (6 items), and *STEM career-related self-efficacy* (5 items). Preliminary psychometric analyses supported the utility and meaningfulness of ***both*** the overall 18-item scale (.90 Alpha Coefficient) as well as the *three sub scales* that operationalize on the three specific dimensions of STEM self-efficacy. (See factor analysis in Appendix A).

STEM self-efficacy is most often assessed by math self-efficacy scales and other scales that focus on beliefs about specific STEM *academic* capabilities (e.g., Betz & Hackett, 1993) or science self-efficacy and other scales that focus on beliefs about specific STEM career capabilities (e.g., Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). However, the Multidimensional STEM Self-Efficacy Scale is more comprehensive and relevant for the current BTAA-SROP study of advanced undergraduate STEM majors in multiple STEM fields than existing measures that only focus on *either* math, science, engineering, etc.

Outcome expectancies. The concept of outcome expectancies originates from the work of John Atkinson who developed an expectancy-value model to examine how expectancies *and* values influence achievement motivation (e.g., Atkinson, 1957, 1968) In his work, Bandura (1977) defined outcome expectancies as beliefs regarding the consequences of a particular course of action. That is, outcome expectancies are the perceived results or desired outcomes of intentional actions in which individuals choose to engage (Bandura, 2001; Fouad & Guillen, 2006). Outcome expectations address the question "If I do this, what will happen?" (Byars-Winston et al., 2010). Outcome expectancies are operationalized using variables concerning students' expectations of STEM-related career outcomes. In this study, two main outcome expectancy measures are employed, *global outcome expectancies* — which are those expectations or beliefs about one's personal control over barriers to life goals, and *path-goal motivational outcome expectancies* — those expectations or beliefs about the relationship between STEM career strivings and the achievement of valued life goals.

Global outcome expectancy. Global outcome expectations, or general outcome expectations, focus on one's generalized beliefs that he or she can personally control life outcomes (Bandura, 1986; P. Gurin, G. Gurin, & Morrison, 1978; Rotter, 1966). To measure global outcome expectations, the John Henryism active coping scale was employed. John Henryism is defined as an "individual's self-perception that one can meet the demand of one's environment through hard work and determination" (James, Hartnett, & Kalsbeek, 1983, p. 263). Accordingly, in this study, I use the John Henryism scale to examine how Women of Color's perceptions about their abilities to succeed in a given context influences their STEM persistence plans despite the normative and non-normative psychosocial barriers that they must overcome in STEM fields. (Williams, 2014). This scale not only shows a high level of reliability, but also has been shown to be especially useful in research with African Americans and other populations faced with systemic life barriers (e.g., James, 1993; James, Harnett, & Kalsbeek, 1983; Mullings, 2002). The John Henryism measure contains 12 items that represent hard work and determination despite obstacles and oppressive circumstances. Participants responded to the items using a 4-point scale (1 = completely false, 2 = mostly false, 3 = mostly true, and 4 = completely true). A complete list of items for this scale is included in Appendix B. Global outcome expectancy scores were calculated by averaging the 12 John Henyrism items. The present study found good internal consistency reliability, with a Cronbach's alpha of .81.

Intrinsic-goal expectancy. Path-goal outcome expectations are operationalized as career path-goal achievement striving. The three types of path-goal outcome expectations in this study are Intrinsic, Organizational, and Societal motivation goals. Intrinsic motivation goals are described in the literature as the inherent tendency to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn (Ryan & Deci, 2000). The construct of intrinsic motivation describes this natural inclination toward assimilation, mastery, interest, and exploration that is essential to cognitive and social development, and represents a source of enjoyment for one's life (Csikszentmihalyi & Rathunde, 1993; Ryan, 1995; Ryan & Deci, 2000). Participants were asked to rate how much successful preparation for a Ph.D. degree and research career would help them in achieving the following outcomes: (a) Self confidence and feelings of accomplishment; (b) A chance to develop personal ideas and values; (c) Greater awareness of yourself and the world. Each response was measured on a 5-point Likert scale from 1=Absolutely necessary to 5 = Absolutely unnecessary. Responses were reverse coded so that higher scores indicated higher degrees of necessity. Scores for this scale were calculated by taking the average across the three items listed. The present study found good internal consistency reliability with a Cronbach's alpha of .84.

Organizational-goal expectancy. Organizational motivation goals refer to the motivation that is influenced externally, from the individual, and is not necessarily for the individual's own interest and enjoyment of the activity (Bandura, 1986; Ryan & Deci, 2000). The construct is the expectancy that an outcome will bring a valued external or structural reward. Participants were asked to rate how much successful preparation for a Ph.D. degree and research career would help them in achieving the following outcomes: (a) Admiration and respect of fellow students; (b) Praise and recognition from your teachers; (c) Credits towards a college degree; and (d) Skills and credits for your chosen career. Each response was measured on a 5-point Likert scale from 1=Absolutely necessary to 5 = Absolutely unnecessary. Responses were reverse coded so that higher scores indicate higher degrees of necessity. Scores for this scale were calculated by averaging across the four items. The present study found fairly good internal consistency reliability with a Cronbach's alpha of .74.

Societal-goal expectancy. The motivation goal outcome expectancies capturing students' societal motivation goals were: Community Uplift, Economic Mobility, and Social Status Mobility. Community Uplift is operationalized as students' belief that attainment of a certain career will help them to contribute to personal civic responsibilities and societal goals. Economic Mobility is operationalized as students' belief that the attainment of a certain career would result in a greater personal economic placement. Social Status Mobility is operationalized as students' belief that the attainment of a certain career will lead to personal development and self-fulfillment. This data was then coded by the following:

Students were asked to read a description of three hypothetical persons and choose a motivation goal outcome expectancy regarding their reason for seeking a college degree. Then, they were asked to choose how similar they were to these hypothetical persons. Following, students were asked if they felt a career field in STEM would lead to one of the hypothetical persons acquiring one or more of the motivation goal outcome expectations. Societal goal motivation is operationalized as the choice or choices of the three motivation goal outcome expectations. If a student selected all three personal outcome expectations, they were assigned a societal motivation goal of "3"; if a student selected two of the three personal outcome expectations, they were assigned a societal motivation goal score of "2"; if a student selected one of the three personal outcome expectations, they were assigned a societal motivation goal of "1"; and if a student did not select any of the three personal outcome expectations, they were assigned a societal motivation goal score of "0".

Perceived natural/ STEM talents. Defined as the predisposition that participants have toward STEM fields as they entered college, students were asked whether they have some specialized talent that they really enjoy (e.g., artistic, mathematical, athletic, creative writing, or other natural abilities). Responses were categorized as 1=”Yes” and 2=”No”. If a students’ response was “Yes”, the student was further prompted to respond to an open-ended question indicating their specialized talent(s). Specifically, participants were asked “What is/are your SPECIALIZED TALENT(S)?” A majority of the students reported one specialized talent. If students indicated more than one talent, only the first listed talent (considered to be the most salient) was used.

The specialized talents responses were coded and categorized into five classifications: STEM-related talents, Arts and Humanistic talents, Athletic and Physical Talents, Social and Empathy talents, and Conscientiousness and Intellectual talents. A dichotomous variable was created where students who indicated STEM-related talents were assigned a value of “1” and those indicating other classifications were assigned a value of “0”. See Appendix C for the coding scheme of this measure.

Socio-cognitive sources of self-efficacy. Bandura (1997) suggested that four primary sources of information are used in the development and modification of self-efficacy beliefs: (1) Social and Verbal Encouragement, (2) Vicarious Learning Experiences (modeling), (3) Mastery Experiences (personal accomplishments), and (4) Emotional Arousal/Physiological and Affective States. Table 4.3 illustrates the hypothesized sources of self-efficacy with the definitions from Bandura (1977a, 1982, 1997) and the conceptualized and operationalized definitions for this study. The following sections provide further detail on how the study constructs were conceptualized, developed, and operationalized. In this study, Social and Verbal Encouragement and Vicarious Learning Experiences are measured as intervention-based experiences, and Mastery Experiences and Emotional/Affective States are measured as prior learning experiences that the student brings to the intervention context.

Table 4.3.Major Hypothesized Sources of Self-Efficacy Information

Construct	Conceptual Definition Bandura (1977, 1982)	Study Construct	Study Measure
Intervention-Based Experiences			
Verbal and Social Persuasion	Suggestive and provisional exhortation that one possesses the capabilities to master difficult tasks	Mentor Encouragement	Research faculty mentor's support and affirmation of readiness for continued and advanced studies in STEM
Vicarious Learning Experiences	Eventual processes by observing others perform activities successfully, modeling	Vicarious Peer Learning	Support from peers affiliated with research experience
Prior Learning Experiences			
Mastery Experiences	Performance Accomplishments, successful performance of a task or behavior, based on personal mastery experiences	Academic Mastery	"Cumulative" GPA from previous semester performance as STEM majors.
Emotional Arousal	Physiological state in judging anxiety/vulnerability to difficulty that may affect one's competency	Student Emotional State	Subset of items from the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977).

Mentor encouragement. Verbal encouragement refers to verbal information and messages conveying encouragement (Hackett & Byars, 1996). Somewhat similar, social encouragement implies a social support system that believes in an individual's capabilities to perform a task as well as provide feedback and encouragement (Rogers & Summers, 2008). Mentor encouragement is measured as the student's report of their research faculty mentor's support and affirmation of their readiness for continued and advanced studies in STEM. Participants were asked to indicate the degree to which they agreed or disagreed with the following statements about their faculty research mentor: (a) *My mentor provides support and encouragement*; (b) *My mentor serves as a sounding board for me to develop and understand myself*; (c) *My mentor thinks highly of me*; (d) *My mentor would use his/her influence to support my advancement*; (e) *My mentor gave me tasks that required me to learn new skills*; (f) *My mentor brings my accomplishments to the attention of important people*; (g) *My mentor helps guide my professional development*; and (h) My mentor sees me as being competent. The items were measured on a 4-point Likert scale (1 = "Strongly Agree", 2 = "Agree", 3 = "Disagree", 4 = "Strongly Disagree"). Responses were reverse coded such that a higher score indicates a greater degree of agreement with statements regarding students' research mentors. A scale was created for this construct by calculating the average across the eight items. The present study found good internal consistency reliability with a Cronbach's alpha of .92.

Vicarious Peer Learning. A vicarious learning experience as a source of self-efficacy is created when an individual has a shared identification with others and sees his or her abilities and circumstances as similar (Rodgers & Summers, 2008). The literature indicates that peers exert one of the most powerful, if not the most salient, influence on college students' experiences and outcome in general (Astin, 1993; Pascarella & Terenzini, 1991, 2005). Indeed, decades of research indicate that involvement in formal and informal activities with peers is positively associated with success. It is through such involvement that racial and ethnic minority students find supportive environments on campus (Guiffrida, 2003; Harper and Quaye, 2007; Maramba and Velasquez, 2012; Palmer, Maramba, & Dancy, 2011). Research has shown that peers have a profound impact on the experiences and outcomes of racial and ethnic minority college students in STEM as well (Bonous-Hammarth, 2000; Cole & Barber, 2003; Cross & Vick, 2001; Hurtado et al., 2007; Johnson, 2007; Museus, Palmer, Davis, & Maramba, 2011). Measured as students' perceived level of support from successful summer undergraduate research intervention peers, vicarious learning is operationalized using variables concerning perceived peer support. Participants were asked if they perceived their intervention peers were available in the following ways: (1) *Tell me about available choices and options*; (2) *Show me how to do something I didn't know how to do*; (3) *Tell me what to do*; (4) *Help me decide what to do*. The items were measured on a 5-point Likert scale (1 = "Definitely yes", 2 = "Probably yes", 3 = "Maybe", 4 = Probably no", 5 = "Definitely no"). Responses were reverse coded such that a higher score indicates a greater degree of support from peers. A scale was created for this variable by averaging of the scores across the four items. The present study found good internal consistency reliability with a Cronbach's alpha of .90.

Academic mastery. Mastery experiences are personal accomplishments from previous performance experiences within the same performance domain. Individuals evaluate the results of their past experiences performing a task within a specific domain, and use these assessments to develop beliefs about their capability to perform subsequent similar tasks or activities within the same domain (van Dinther et al., 2011) For this study sample, Women of Color in STEM majors, STEM is the relevant academic domain, and "cumulative" GPA represents mastery experiences from previous semesters performance as STEM majors (i.e., "personal accomplishments from previous performance experiences within the same performance domain.", van Dinther, Dochy, & Segers, 2011). For STEM majors, semester GPA (previous performance) and cumulative (mastery experiences) GPA both reflect academic, research, and career-related accomplishments in the STEM domain. STEM Academic Mastery is operationalized using students' self-reported cumulative college grade point average at Time 1. Students were asked to indicate the scale on which their GPA was calculated. Because GPAs were measured using different scales, responses were converted as necessary to reflect a 4-point scale.

Student emotional state. Emotional state is a source of self-efficacy information where one draws personal physiological, emotional, and dispositional states (van Dinther et al., 2011). Individuals rely in part on these states in assessing their capabilities when perceiving and interpreting self-efficacy information in conjunction with the other three sources (Pajares, 1997). Measured as students' level of depressive affect and symptoms, emotional state is operationalized using variables concerning an individual's level of depressive affect. A subset of items from the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977) was used to assess depressive affect. The original 20-symptom CES-D is a frequently used measured of depressive affect in nonclinical, as well as patient populations. A total score on the scale is obtained by summing the response across all 20 symptoms; higher scores on the scale represent greater degrees of depressive effect. The CES-D has exhibited a high degree of reliability and has been found to be moderately to highly correlate with other measures of depressive affect.

In this present study, a simplified scale consisting of six items from the full CES-D scale (included in the parent study) was used in this present study to gather data on students' emotional state. Instructions accompanying these items ask respondents to indicate how often within the past week they felt what each statement describes The six items are: (1) *I felt depressed*; (2) *I could not get "going"*; (3) *I thought my life had been a failure*; (4) *I felt sad*; (5) *I enjoyed life*; (6) *I felt hopeful about the future*. Two of the questions (#5, #6) were reverse-coded so that higher values indicate greater levels of negative affect. The items were measured on a 4-point scale (1 = "Rarely or none of the time (< day)", 2 = "Some or a little of the time (1-2 days)", 3 = "Occasionally or a moderate amount of time (3-4) days", 4 = "Most or all of the time (5-7 days) ". Computing the mean over the six items created a depressive affect score for each research participant. The present study found good internal consistency reliability with a Cronbach's alpha of .80.

Socio-cultural context. Researchers employing SCCT assert that contextual factors moderate persistence through their effect on self-efficacy (Byars-Winston et al., 2010; Byars-Winston & Fouad, 2008; Lent et al., 1994, 2000, 2003, 2005). This study will examine the impact of Women of Color's perceptions of socio-cultural contextual factors on their STEM persistence plans. Contextual factors are viewed as features of the environment or socio-structural conditions that can be appraised and perceived as supports or barriers (Byars-Winston et al., 2010; Byars-Winston & Fouad, 2008). Two indicators of the socio-cultural context include: (1) *Role-Strain Contextual Barriers* assessed with self-reported perceived experiences of racial and gender discrimination and objective self-reports of low-income status and (2) *Adaptive Role Contextual Supports* assessed with a 14-item race-related socialization scale of perceived strong family support and objective indications of the students' racial/ethnic composition of their home institution.

Role-strain contextual barriers.

Perceived discrimination contextual barrier. Contextual barriers refer to the social aspects identified as critical to historically underrepresented minority student retention, such as perceptions of prejudice and discrimination (Byars-Winston et al., 2010; Cabrera et al., 2001) that can interfere in the process of one pursuing a career in STEM. Women of Color in undergraduate STEM programs have reported experiences of gender and racial or ethnic micro-aggressions in predominantly male and White classrooms (Sosnowski, 2002). Others have reported feeling unwelcomed, unsupported (Varma, Prasad, & Kapur, 2006), or invisible (Ong, 2005) due to how their gender and racial or ethnic status affects their relationships with both peers and faculty (Justin-Johnson, 2004; Ong, 2005). Perceived Discrimination is operationalized as students' reported measure of racial and gender discrimination experiences. Students were asked if they have ever experienced any form of discrimination, harassment, or discomfort at their respective university because of their gender, race, or cultural background. A dichotomous variable was created where students who indicated that they experienced a form of discrimination were assigned a value of "1" and those that indicated that they have not experienced a form of discrimination were assigned a value of "2".

Low-income contextual barrier. Financial constraints play a role in persistence plans (Gullatt & Jan, 2003; St. John, 1994) and lower income students are more likely to be constrained by their economic circumstances (Carter, 2006). To operationalize income status, this study used students' receipt of a Pell Grant award and/or college work-study. Students were asked whether they received a Pell Grant, college work-study, both, or neither when they started college. A dichotomous variable was created to indicate receipt of college financial aid targeted toward lower-income students. Students who received a Pell Grant and/or work-study were coded "1. Those students that did not receive either were coded as "0".

Adaptive role contextual supports.

Perceived racial socialization contextual support. To assess the impact of students' perceived contextual supports on their STEM persistence plans, this study utilized items from a scale originally employed by Bowman and Howard (1985), race-related familial socialization. Race-related socialization offsets environmental adverse effects that may discourage academic pursuits related to a career in STEM (Bowman & Howard, 1985). Fourteen items asked about the students' race-related socialization. Examples of the items included are Did your PARENTS or the PEOPLE WHO RAISED YOU, ever teach you that; *"Despite life obstacles, you must believe in yourself?"*, *"If you are determined enough you can break down major life barriers to success?"* The fourteen items were measured on a 3-point scale (1 = "Do not remember/Never", 2 = Once/Sometimes, 3 = "Always"). A scale was created for this variable by calculating the average of the scores across the fourteen items. The present study found good internal consistency reliability with a Cronbach's alpha of .88. The survey questions for this construct are in Appendix B.

Racial/ethnic majority campus contextual support. Research suggests that minority-serving institutions might have a positive effect on success among minority students in STEM (Fries-Britt, Younger, & Hall, 2010; Perna, et al., 2008). These institutions provide supportive environments that mitigate potential negative academic and psychological barriers to facilitate students' success in STEM. Of the Black/African American doctorate recipients in Science and Engineering from 2011-2015, 24% received their baccalaureate degrees from a historically Black College or University, and of Hispanic doctorate recipients in Science and Engineering, 29% earned their baccalaureates from a high-Hispanic enrollment institution (National Science Board, 2018). To assess the impact of students' objective supports, students were asked the racial composition of their home campus. This item was measured on a 5-point scale (1 = "All/Almost all persons of my ethnic group", 2 = "Mostly persons of my ethnic group", 3 = "About half of my ethnic group", 4 = "Mostly persons of other ethnic groups", 5 = "All/Almost all persons of other ethnic groups"). A dichotomous variable was created where students who answered "All/Almost all persons of my ethnic group to "About half of my ethnic group" were assigned a value of "1", and for those students who answered "Mostly persons of other ethnic groups" or "All/Almost all persons of other ethnic groups" were assigned a value of "0".

Other persistence predictors. To address other possible explanations for my findings, I employ various traditional persistence predictors from the higher education literature. This is one strategy to examine the plausibility of alternative explanations when random assignment is not possible (Maruyama & Ryan, 2014).

Undergraduate STEM major. The National Science Board, of the National Science Foundation, (NSB-NSF, 2018), reports that men and women tend to choose different STEM fields of study and that these proclivities remain at the master's and doctoral levels. In 2015, men earned a large majority of bachelor's degrees in engineering, computer science, physics, and mathematics, while women earned half or more of the bachelor's degrees in psychology, life sciences, and social sciences (NSB-NSF 2018). Moreover, when examining STEM occupations, there was near gender parity among life scientists (48% women), with the largest component in the biological and medical sciences slightly surpassing parity (53% women) and the social sciences exceeding parity (60% women) (NSB-NSF, 2018). To assess the impact of the type of major within STEM, participants were asked to select the field most related to their major among the following options: Biomedical/Behavioral Sciences; Other Basic or Applied Sciences (e.g., Physics, Engineering); and Social Sciences (e.g., Psychology, Economics). The type of STEM major was coded as a dichotomous variable where students who identified a major in "Other Basic or Applied Sciences" were assigned "0", and the "Biomedical/Behavioral Sciences" and "Social Sciences" were assigned "1".

Summer research experience. As noted previously noted, this study focuses on students who *applied* for the 2011 BTAA-SROP and agreed to participate in the longitudinal survey study. The sample for this study, Women of Color (Black/African American and Hispanic) includes: (1) Women of Color who applied and participated in the BTAA-SROP; (2) Women of Color who applied to the BTAA-SROP, but participated in a similar SROP-type summer undergraduate research program, and; (3) Women of

Color who applied to the BTAA-SROP, but did not participate in any summer undergraduate research program for various reasons. To assess the relationship between undergraduate research participation and STEM persistence plans, summer research experience participation was coded as a dichotomous variable where students who did not participate in a summer undergraduate research experience were assigned a “0”, and participants who did participate in a summer undergraduate research experience were assigned a “1”.

Grades. Students who apply to the BTAA-SROP are high performing and highly motivated undergraduates from diverse backgrounds and who are interested in pursuing advanced Ph.D. studies and faculty research careers. To be eligible to apply, students must have a 3.0 cumulative grade point average or higher (on a 4.0 scale) and have a strong interest in pursuing a Ph.D. There are some cases in which students are eligible with a grade point average slightly below a 3.0; however the majority of students have a grade point average of 3.0 or higher on a 4.0 scale. Both institutional and national studies have been conducted to examine the relationship between college academic performance and persistence (e.g., Gifford, Bricenso-Perriott, & Mianzo, 2006; Pascarella & Terenzini, 2005; Reason, 2003; Stewart, Lim & Kim, 2015). On their comprehensive review of the college impact literature, Pascarella and Terenzini (2005) found college grades as a consistent predictor of persistence and degree completion (Stewart, Lim & Kim, 2015). In his review on the college retention literature, with an emphasis on the increasing diversity of undergraduate students, Reason (2003) reported a significant correlation between students’ academic performance and college persistence (Stewart, Lim & Kim, 2015).

In the current study, students were asked to indicate the scale on which their GPA was calculated. Because GPAs were measured using different scales, responses were converted as necessary to reflect a 4-point scale. The converted GPAs were measured on a 4-point Likert scale (1 = “GPA=4.0”, 2 = “GPA 3.9-3.0, 3 = “GPA = 2.9-2.0” 4 = “GPA less than 2.0”). These grades were coded as such to examine the relationship of the GPA range and STEM persistence plans.

Student year. BTAA-SROP targets primarily juniors and rising seniors to introduce the research enterprise and promote success in graduate studies and faculty research careers. Participants were asked to indicate their college standing: freshman, sophomore, junior or senior. Freshmen were assigned a value of “1”; sophomores a value of “2”; juniors a value of “3”, and senior a value of “4”. In their study on student persistence, Allen, Robbins, Casillas, and Oh (2008) examined third-year enrollment status, rather than first-year retention, suggesting that third-year enrollment may be a stronger predictor of degree attainment. This persistence proxy may also be important to investigate STEM persistence plans in this study sample, as they are near the undergraduate-to-graduate program transition. Factors influencing later year persistence may be considerably different from those influencing persistence in the first year (Willcoxson, Cotter, Joy, 2011). The majority of the study participants were of junior and senior class standing (See Table 4.1).

Race and ethnicity. While socio-cognitive motivation may be shared across the

Women of Color in this study, because of the general status of STEM underrepresentation by both race and gender, some socio-cognitive motivation processes may be subject to within-group variation (Byars & Hackett, 1998). A new dichotomous variable was created to examine the relationship between each racial/ethnic subgroup and STEM persistence plans. African American/Black participants were assigned a value of "1" and Hispanic/Latina American participants were assigned a value of "2". In this study sample, 70% self-identified as African American/Black, and 30% as Hispanic/Latina American (See Table 4.1).

Age. According to the National Center for Educational Statistics (NCES), approximately one third of undergraduate students enrolled in 2011 were regarded as nontraditional students, defined by being 25 years or older (Markle, 2015). Interestingly, between 2008 and 2019, the projected enrollment of students between 25 to 34 years of age is expected to increase by 28%, and by 22% for students age 35 or older, compared to just 12% for students considered traditional college age of 18 to 24 years (Markle, 2015; NCES, 2011). However, despite promising enrollment estimations, studies on these adult students have indicated they have lower persistence rates than traditional age students (e.g., Bergman, Gross, Berry, Shuck, 2014; Markle, 2015, Soares, 2013). For example, the NCES indicated that 64% of 18-year old students enrolled in 2003-2004 graduated within 6 years compared to 20% of those that enrolled at the age of 24 to 29 years. (Markle, 2015; NCES, 2011). Participants were asked to indicate the year of their birth. Age was calculated by subtracting the participants' birth year from the year of the survey (2011). Ages were then coded, with the consideration of the traditional college age for upperclassman. Participants age 19 years or younger were assigned the value of "1", participants age 20-23 years, a value of "2", and participants 24 years of age and older were assigned a value of "3". The majority of Women of Color participants were of traditional undergraduate college age, with 83% being of age 20-23 years of age (See Table 4.1).

Mother's educational background. Researchers investigating factors that affect student retention suggest that college persistence varies by parents' highest level of education (e.g., Isitani, 2006; 2016). Students for whom neither of their parents completed a college degree are less likely to persist than their counterparts whose parents, either mother or father, or both, have at least completed a baccalaureate degree (Ishitani, 2016; U.S. Department of Education, 2011). Mother's educational background was selected as a variable as some studies have shown that mothers' educational level more strongly predicts college persistence than fathers' educational level (Maton & Hrabowski, 2004; St. John, Kirshstein, & Novell, 1991; St. John, Paulsen, Starkey, 1996). To examine the relationship of mother's educational background on STEM persistence plans, participants were asked to indicate the highest number of years of school completed by their mother. The choices were: 1 = 1-8 years; 2 = 9-11 years; 3 = High School graduate; 4 = Some college; 5 = Four year degree (e.g., B.A., B.S.); 6 = Master's degree (e.g., M.A., M.S.), 7 = Doctoral degree (e.g., Ph.D., M.D.), and 8 = Not sure. Mother's education background was reassigned to a value of "0" for less than a four year degree, "1" for a four year degree, and "2" for a master's degree or higher. There were two participants who indicated "Not Sure" for mother's educational background. These two participants' responses were recoded to a value of "0".

Data Analysis Procedures

Descriptive statistics provided some initial insights about each study variable and allowed me to observe emerging patterns and measures of frequency, central tendency, and dispersion for the study sample. I then used psychometric techniques to identify items to combine and form the composite scores representing the theoretical constructs for the predictor variables for Global Outcome Expectancy, Intrinsic Goal Expectancy, Organizational Goal Expectancy, Mentor Encouragement, Vicarious Peer Learning, Student Emotional State, and Perceived Racial Socialization Contextual Support. I calculated a Cronbach's alpha coefficients as measures of reliability in order to determine the appropriate use of the aforementioned scales for this sample. After ensuring internal consistency, I created variables by averaging each student's responses for each of the respective scales' items. Afterwards, an inter-correlation matrix was created to examine the relationships among the predictor variables; this approach allowed me to determine how each predictor variable was related to other variables and to check for multicollinearity. A zero-order correlation matrix was also created to examine the relationships between the predictor variables and the outcome variables. The inter-correlation matrix and zero-order correlation matrix are shown in the preliminary analysis in the beginning of the Results Chapter 5.

Multiple regression is the primary analytic approach used herein to investigate the six research questions and related hypotheses specified earlier. The primary aim of this study is to explore socio-cognitive motivation and STEM persistence plans among Women of Color (i.e., African American and Hispanic American women) in STEM majors. Guided by the RSCCM conceptual framework, multiple regression analysis is an appropriate statistical method to investigate the hypothesized relationships between various socio-cognitive motivation predictors and STEM persistence plans given the study's sample size. Building on expectancy-value and role-strain theories, this investigation explores specific research questions and hypotheses derived from the RSCCM regarding various socio-cognitive motivation predictors and STEM persistence plans. Given the theory-driven research questions and hypotheses, the appropriateness of multiple regression models that include self-efficacy and other key socio-cognitive motivation predictors may help us further understand STEM persistence and STEM career plans among Women of Color.

An example of the multiple regression model related to each research question is illustrated as follows:

$$\hat{Y} = b_0 + \ b_1 X_1 + b_2 X_2 + \ b_p X_p$$

where $\hat{Y}$ represents the predicted value of the outcome variable STEM Persistence Plans, X_1 through X_p are p distinct predictor variables, b_0 is the value of Y when all of the predictor variables are equal to zero, and b_1 through b_p are the estimated regression coefficients.

Chapter 5 Results

This results chapter presents the study findings to provide new insights into the relationships between socio-cognitive motivation predictors and STEM persistence plans among Women of Color in STEM majors. This chapter is organized around subsections that focus on the study's major research questions and related hypotheses. Within each subsection, the major question is addressed by presenting results for each related hypothesis. I begin with presenting information about the study sample, Women of Color, for each of the measures previously discussed. Then I present each major research question with related hypotheses and empirical findings. Guided by my Reformulated Social-Cognitive Career Model (RSCCM), the findings in each of these sections focus on hypothesized relationships between key socio-cognitive motivation predictors and three STEM persistence plan pathways for Women of Color — STEM Major Plans, Ph.D. Plans, and STEM Research Career Plans.

Preliminary Analyses

Table 5.1 presents the means, standard deviations, and inter-correlations of the study variables for the Women of Color study sample. The predictors included in this study align with Expectancy-Value Theory (including the Theory of Planned Behavior) and Role Strain theoretical foundations for the RSCCM hypotheses being tested. Before conducting multiple regression analyses examining how socio-cognitive motivation predictors relate to Women of Color's STEM persistence plans, it was important to run Pearson correlations to examine interrelationships among the socio-cognitive motivation predictor variables within the regression models in this study. As shown in table 5.1, results indicated that in no case did the correlations exceed the criteria of ($r \geq .80$) and supports the assumption that multicollinearity was not a problem for these socio-cognitive motivation predictor variables (e.g., Aiken & West, 1991). Table 5.1 also shows the means, standard deviations, and inter-correlations among the three STEM persistence plans outcome variables. ANOVA comparisons between the Women of Color study sample and other relevant sub-samples can be found in Appendix E. Table 5.2 shows the zero-order correlations between the socio-cognitive motivations predictors and STEM persistence plan outcomes.

Table 5.1 Means, Standard Deviations, and Intercorrelations for Socio-Cognitive Motivation Predictors and STEM Persistence Plans for Women of Color Sample (N=179)

Socio-Cognitive Motivation Predictors	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Multidimensional STEM Self -Efficacy	3.95	.58	—													
Outcome Expectancies																
2. Global Outcome Expectancy	3.20	.35	.20*	—												
3. Intrinsic-Goal Expectancy	4.38	.81	.15	.11	—											
4. Organizational-Goal Expectancy	4.02	.82	.05	-.10	.51**	—										
5. Societal-Goal Expectancy	1.04	1.23	.01	-.10	.05	-.09	—									
Intervention-based Experiences																
6. STEM Mentor Social and Verbal Persuasion	3.28	.52	.25*	.11	.02	.11	.13	—								
7. Vicarious Intervention Peer Learning	4.36	.73	.06	.09	-.10	.00	-.01	.08	—							
8. STEM Academic Mastery (Cum. GPA)	3.60	.33	.08	-.08	.11	.15	.01	.06	.09	—						
9. Student Emotional State (CESD Depression)	1.52	.64	-.01	-.08	.05	.22	-.16	-.03	-.15	-.08	—					
10. Perceived STEM/Natural Talents	.04	—	-.10	-.05	-.22*	-.16	.16*	-.16	.06	-.01	-.09	—				
Perceived Socio-Cultural Context																
11. Perceived Discrimination (Racial/Gender)	1.70	—	0.11	.05	-.06	-.04	.03	.27*	-.01	-.02	.03	.05	—			
12. Low Income (Pell Grant Eligibility)	.63	—	-.07	.00	.09	0.15	-.10	.03	-.01	-.24**	.07	-.03	-.18	—		
13. Perceived Racial Socialization	2.54	.39	.24*	.26*	-.07	.12	-.08	.04	.28*	-.18	-.05	.08	.15	-.15	—	
14. Racial/Ethnic Majority Campus[a]	.59	—	.14	.15	.10	.27*	.003	.02	.25*	-.06	-.07	-.08	.33**	.01	.26*	—

Note. [a]Student's Home Campus
*$p \le .05$, **$p \le .01$, ***$p \le .001$
SD presented for continuous variables; not relevant for dummy-coded (categorical) variables

STEM Persistence Plans	Mean	Std. Dev.	1	2	3
1. STEM Major Plans	3.09	1.91	—		
2. Ph.D. Plans	4.14	1.02	-.15	—	
3. STEM Research Career Plans	2.61	1.38	.77**	-.01	—

*$p \le .05$, **$p \le .01$, ***$p \le .001$

Table 5.2. Zero-order correlations between socio-cognitive motivation predictors and STEM persistence plans (N=179)

Socio-Cognitive Motivation Predictors	STEM Persistence Plans		
	STEM Major Plans	Ph.D. Plans	STEM Research Career Plans
1. Multidimensional STEM Self -Efficacy	.10	.29**	.08
Outcome Expectancies			
2. Global Outcome Expectancy	.11	-.09	-.04
3. Intrinsic-Goal Expectancy	-.24	.37**	-.25*
4. Organizational-Goal Expectancy	-.07	.19	-.17
5. Societal-Goal Expectancy	.13	.17	.05
Intervention-based Experiences			
6. STEM Mentor Social and Verbal Persuasion	.08	.05	.20
7. Vicarious Intervention Peer Learning	.07	.09	-.01
8. STEM Academic Mastery (Cum. GPA)	-.13	.03	-.15
9. Student Emotional State (CESD Depression)	-.01	-.17	-.05
10. Perceived STEM/Natural Talents	.14	.19	.21
Perceived Socio-Cultural Context			
11. Perceived Discrimination (Racial/Gender)	.23	-.04	.29**
12. Low Income (Pell Grant Eligibility)	.00	.00	-.13
13. Perceived Racial Socialization	.16	.08	.20
14. Racial/Ethnic Majority Campus[a]	.12	-.06	.09

Note. [a]Student's Home Campus
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

<u>Research Question 1</u>: How do STEM-related socio-cognitive motivation predictors (self-efficacy and outcome expectations) predict STEM persistence for Women of Color?

The first research question was formulated to examine the relationship of two key socio-cognitive motivation predictors and STEM persistence plans among Women of Color in STEM majors. In general, this research question focuses on how STEM-self-efficacy *and* various outcome expectancies predict STEM persistence plans for Women of Color in STEM majors. While traditional SCCT focuses on the central role of self-efficacy, the RSCCM places an equal emphasis on outcome expectancies, building on foundational propositions from Expectancy-Value Theory. Therefore, guided by the RSCCM, the first hypothesis related to this research question is that STEM self-efficacy and various outcome expectancies have independent effects on STEM persistence plans.

Hypothesis 1a: Self-efficacy and outcome expectancies have separate effects on STEM persistence plans. As shown in Table 5.3, I employed multiple regression analyses to investigate the hypothesized relationships between a set of five core socio-cognitive motivation predictor variables and each of three STEM persistence plans outcome measures — STEM Major Plans, Ph.D. Plans, and STEM Research Career Plans. More specifically, the set of five key socio-cognitive motivation predictors include STEM Self-Efficacy, Global Outcome Expectancy, and three Path-Goal Outcome Expectancies – Intrinsic-goal expectancy, Organizational-goal expectancy, and Societal-goal expectancy. Together, results from the regression models in Table 5.3 help to explain the operation of core socio-cognitive motivation predictors and the STEM persistence plans of Women of Color in STEM undergraduate majors. The next section presents specific regression results for Women of Color persistence plans in their undergraduate STEM

Major, followed by results for Ph.D. Plans and STEM Research Career Plans.

Table 5.3. Multiple Regression Analyses Examining the Relationships of STEM Self-Efficacy, Outcome Expectancies, and STEM Persistence Plans among Women of Color

	STEM Persistence Plans		
	STEM Major Plans (N=48)	Ph.D. Plans (N=62)	STEM Research Career Plans (N=61)
Socio-Cognitive Motivation Predictors	*B (SE)*	*B (SE)*	*B (SE)*
(Constant)	**-3.09 (3.13)**	**4.82 (1.76)****	**2.98 (2.36)**
Multidimensional STEM Self-Efficacy	**0.54 (.41)**	**0.42 (.20)***	**0.30 (.27)**
Outcome Expectancies			
Global Outcome Expectancy	**1.26 (.91)**	**-1.33 (.49)****	**-0.29 (.66)**
Intrinsic-Goal Expectancy	**-0.94 (.32)****	**0.43 (.17)***	**-0.44 (.23)**
Organizational-Goal Expectancy	**0.48 (.36)**	**-0.02 (.18)**	**-0.02 (.24)**
Societal-Goal Expectancy	**0.93 (.24)*****	**0.08 (.14)**	**0.53 (.19)****

Note*. STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,* 2) *Pretty certain will not,* 1) *Completely certain will not
$*p \leq .05$, $**p \leq .01$, $***p \leq .001$

STEM Major Plans

As illustrated in Table 5.3, the first multiple regression model equation for STEM Major Plans was found to be significant predictor of STEM Major Plans ($F(5, 42) = 5.07$, $p < .001$), with an R^2 of .38; about 38% of the variance for STEM major plans among Women of Color in STEM majors can be explained by STEM self-efficacy and the four outcome expectancies in the model. Counter to traditional SCCT, in this analysis STEM self-efficacy and STEM Major Plans were not significantly related. However, in support of my RSCCM, two of the four outcome expectancies were significantly associated with STEM Major Plans. In this regression analysis, while global outcome expectancy and organizational-goal expectancy were unrelated to STEM Major Plans, path-goal outcome expectancies for both intrinsic and societal goals were significantly related to STEM Major Plans among undergraduate Women of Color in STEM majors. Surprisingly, intrinsic-goal expectancy and STEM Major Plans had a negative relationship, suggesting that Women of Color with higher intrinsic-goal motivation may have lower plans to persist in their STEM undergraduate majors. However, societal-goal expectancy was positively associated with plans among Women of Color to persist in their STEM majors, suggesting that Women of Color with high societal-goal motivation may more often intend to persist in their STEM undergraduate majors. These findings suggest that while considering socio-cognitive motivation predictors such as STEM self-efficacy, various outcome expectancy motivations are also important to consider for Women of Color intentions to complete their undergraduate major in STEM. In this study, results indicated that Women of Color may be motivated by their intrinsic-goal outcome expectancies and societal-goal outcome expectancies to continue with their plans to major in STEM.

Ph.D. Plans

A similar multiple linear regression was conducted using the same predictor variables (STEM self-efficacy and four outcome expectancies) to predict undergraduate Women of Color's plans to pursue a doctoral degrees. The regression model was found to explain a significant ($F(5, 56) = 4.04$, $p < .01$) portion of the variance ($R^2 = .27$) in Ph.D. plans among Women of Color in STEM.

In line with the traditional SCCT, STEM self-efficacy was significantly associated with Ph.D. plans. In support of my RSCCM, various outcome expectancies *also* have significant relationships with Ph.D. plans. While path-goal organizational and societal motivational goals were unrelated to the pursuit of a doctoral degree among Women of Color, global outcome expectancies and path-goal expectancy for intrinsic motivation goals were significantly related to Ph.D. plans. Global outcome expectancy was negatively related to Ph.D. plans, suggesting that in the current sample, undergraduate Women of Color in STEM majors who have a strong self-perception of their personal resiliency are less certain that they will pursue a Ph.D. However, intrinsic-goal expectancy was positively associated with Ph.D. plans, suggesting that undergraduate Women of Color in STEM majors with high intrinsic-goal motivation may be more likely to pursue a Ph. D.

STEM Research Career Plans

I conducted a similar multiple linear regression to predict Women of Color's plans to pursue a STEM research career. The regression model was found to explain a significant proportion of the variance in Women of Color's plans to pursue a STEM research career ($F(5, 55) = 3.07$, $p < .05$), with an R^2 of .22. This model shows that about 22% of the variance for STEM research Career plans among Women of Color in STEM majors in the current sample can be explained by STEM self-efficacy and various outcome expectancies.

In contrast to traditional SCCT, STEM self-efficacy did not have a significant relationship to STEM research career plans for Women of Color in STEM majors. However, in support of my RSCCM, various outcome expectancies and STEM research career plans were significantly related. In this regression analysis, while global outcome expectancy, intrinsic-goal and organizational-goal outcome expectancies were unrelated to STEM research career plans, path-goal outcome expectancy for societal goals did have a positive, significant relationship to STEM research career plans among Women of Color. These findings suggest that, in lieu of having high self-efficacy as suggested by traditional SCCT frameworks, Women of Color in STEM majors with high societal-goal motivation may more likely plan to pursue a STEM research career.

The analyses for this hypothesis show the role of socio-cognitive motivation predictors varying across the three STEM persistence outcomes. Except for Ph.D. plans, outcome expectancies—rather than STEM self-efficacy—appear to affect STEM persistence plans among Women of Color in STEM majors.

Hypothesis 1b: **Self-Efficacy and Outcome Expectations also have significant *interaction effects* on STEM persistence plans.** Guided by the RSCCM, my second hypothesis related to my first research question is that STEM self-efficacy and various outcome expectancies have interaction effects on STEM persistence plans. Consistent with expectancy X value propositions, this RSCCM hypothesis explores how two key STEM-related socio-cognitive motivation predictors — STEM self-efficacy and outcome expectations — may interact to predict STEM persistence plans among Women of Color in STEM majors. As shown in Table 5.4, results from multiple regression including various STEM self-efficacy X Outcome expectancy interaction terms are presented to help further explain variance in Women of Color's STEM persistence plans.

For a more in-depth analysis of their STEM persistence plans, these interaction terms were developed to explore the interaction effects of STEM self-efficacy with each of the four outcome expectancy motivation predictors: Global Outcome Expectancy, and three Path-Goal Outcome Expectancies (Intrinsic-goal expectancy, Organizational-goal expectancy, and Societal-goal expectancy). The following sections show the regression results for each of the three STEM persistence plan outcome variables — STEM Major Plans, Ph.D. Plans, and STEM Research Career Plans.

Table 5.4. Multiple Regression Analyses Examining the Relationships of STEM Self-Efficacy, Outcome Expectancies, their Interactions and STEM Persistence Plans among Women of Color

	STEM Persistence Plans		
	STEM Major Plans (N=48)	Ph.D. Plans (N=62)	STEM Research Career Plans (N=61)
Socio-Cognitive Motivation Predictors	*B (SE)*	*B (SE)*	*B (SE)*
(Constant)	9.38 (19.19)	-6.00 (10.40)	6.64 (14.29)
Multidimensional STEM Self -Efficacy	-2.57 (5.17)	3.23 (2.75)	-0.60 (3.78)
Outcome Expectancies			
Global Outcome Expectancy	-0.59 (5.02)	3.27 (2.73)	-1.10 (3.75)
Intrinsic-Goal Expectancy	1.74 (2.39)	-0.07 (1.28)	0.23 (1.76)
Organizational-Goal Expectancy	-3.23 (2.28)	-0.46 (1.09)	-0.66 (1.50)
Societal-Goal Expectancy	-0.51 (1.53)	0.26 (.88)	-0.09 (1.21)
Interactions			
Multidimensional STEM Self-Efficacy x Global Outcome Expectancy	0.43 (1.31)	-1.18 (.70)	0.20 (.96)
Multidimensional STEM Self-Efficacy x Intrinsic-Goal expectancy	-0.70 (.62)	0.13 (.32)	-0.17 (.45)
Multidimensional STEM Self-Efficacy x Organizational-Goal Expectancy	0.96 (.58)	0.10 (.26)	0.16 (.36)
Multidimensional STEM Self-Efficacy x Societal-Goal Expectancy	0.40 (.41)	-0.04 (.23)	0.17 (.32)

Note. STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,* 2) *Pretty certain will not,* 1) *Completely certain will not*
$*p \leq .05$, $**p \leq .01$, $***p \leq .001$

STEM Major Plans

In this regression analysis, the interaction effects of STEM self-efficacy and global outcome expectancy did not significantly relate to STEM major plans among Women of Color in STEM majors. Similarly, the interaction effects of STEM self-efficacy and the three path-goal outcome expectancies — Intrinsic-goal expectancy, Organizational-goal expectancy, and Societal-goal expectancy — did not have a significant relationship to STEM major plans among Women of Color in STEM majors.

Ph.D. Plans

In this regression analysis, the interaction effects of STEM self-efficacy and global outcome expectancy did not have a significant relationship to Ph.D. plans among Women of Color in STEM majors. Similarly, the interaction effects of STEM self-efficacy and the three path-goal outcome expectancies — Intrinsic, Organizational, and Societal goals — also did not have a significant relationship to Ph.D. plans

STEM Research Career Plans

The interaction effects of STEM self-efficacy and global outcome expectancies did not have a significant relationship to STEM research career plans in this analysis. The interaction effects of STEM self-efficacy and the three path-goal outcome expectancies — Intrinsic-goal expectancy, Organizational-goal expectancy, and Societal-goal expectancy — also did not have a significant relationship to STEM research career plans among Women of Color in STEM majors.

The analyses for this hypothesis show that once the interaction of the socio-cognitive motivation predictors with STEM self-efficacy are added to the model, the main effect of the socio-cognitive predictors are minimized.

<u>Research Question 2</u>: How do STEM *intervention-based* experiences (mentor encouragement and vicarious peer learning) and *prior learning* experiences (academic mastery and emotional state) predict STEM self-efficacy and outcome expectations among Women of Color?

To advance the RSCCM, the second research question was designed to better understand how intervention-based and prior learning experiences predict key socio-cognitive motivation factors among Women of Color in STEM majors. Extending traditional SCCT to STEM intervention contexts, Research Question 2 explores how STEM-related intervention-based experiences and prior learning experiences predict STEM self-efficacy and outcome expectations among Women of Color. To address this second research question, I employed separate multiple linear regression models to explore two hypotheses that consider the influence of learning experiences on both STEM self-efficacy and Outcome expectancies.

Hypothesis 2a: Intervention-based experiences and prior learning experiences are significantly related to STEM self-efficacy among Women of Color. Hypothesis 2a states that four types of experiences, mentor encouragement, vicarious peer learning, academic mastery, and emotional state, are significantly related to STEM self-efficacy among Women of Color in STEM majors. Table 5.5 reveals the regression analyses for learning experiences and STEM self-efficacy among Women of Color. The following sections detail the results for each learning experience in association with STEM self-efficacy.

Table 5.5. Multiple Regression Analysis of the relationship of Intervention-based and Prior Learning Experiences and STEM Self-Efficacy among Women of Color

	Socio-Cognitive Motivation Factor STEM Self-Efficacy
Intervention-based Experiences	(N=73) *B (SE)*
(Constant)	2.54 (.96)**
STEM Mentor Social and Verbal Persuasion	0.38 (.14)**
Vicarious Intervention Peer Learning	-0.01 (.10)
STEM Academic Mastery (Cum. GPA)	0.02 (.21)
Student Emotional State (CESD Depression)	-0.01 (.11)

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

STEM Self-Efficacy

As illustrated in Table 5.5, the regression model as a whole did not explain a significant proportion of the variance in STEM self-efficacy ($F(4, 68) = 1.97$, $p = .11$), with an R^2 of .10, accounting for about 10% of the variance for STEM self-efficacy among Women of Color in STEM majors. In line with traditional SCCT, mentor encouragement had a significant univariate relationship to STEM self-efficacy. However, in contrast with traditional SCCT, vicarious peer learning, academic mastery, and emotional state were unrelated to STEM self-efficacy. In this study, these findings suggest that mentor encouragement positively influenced STEM self-efficacy among Women of Color in STEM majors, while other learning experience measures of vicarious peer learning, academic mastery, and emotional state did not have significant relationships to STEM self-efficacy.

Hypothesis 2b: Intervention-based experiences and prior learning experiences are significantly related to various STEM outcome expectancies among Women of Color. Going beyond the traditional SCCT focus on self-efficacy, hypothesis 2b is that four types of learning experiences — mentor encouragement, vicarious peer learning, academic mastery, and emotional state — are also significantly related to four outcome expectancies among Women of Color in STEM majors.

I conducted similar multiple linear regressions using the same learning experiences to predict four outcome expectancies among Women of Color. Table 5.6 shows the regression analyses for learning experiences and outcome expectancies among Women of Color in STEM majors. The outcome expectancies are Global outcome expectancies, and three path-goal motivation outcome expectancies; Intrinsic-goal expectancy, Organizational-goal expectancy, and Societal-goal expectancies.

Table 5.6. Multiple Regression Analyses of the relationships of Intervention-based and Prior Learning Experiences and STEM Outcome Expectancies among Women of Color

	Socio-Cognitive Motivation Predictors			
	Global Outcome Expectancy (N=72)	Intrinsic-Goal Expectancy (N=51)	Organizational-Goal Expectancy (N=51)	Societal-Goal Expectancy (N=74)
Intervention-based Experiences	*B (SE)*	*B (SE)*	*B (SE)*	*B (SE)*
(Constant)	2.84 (.62)***	2.99 (1.72)	.83 (1.58)	2.90 (2.00)
STEM Mentor Social and Verbal Persuasion	.05 (.09)	0.14 (.28)	0.17 (.25)	0.11 (.28)
Vicarious Intervention Peer Learning	0.04 (.07)	-.08 (.18)	0.01 (.17)	-.27 (.21)
STEM Academic Mastery (Cum. GPA)	0.01 (.14)	0.36 (.37)	0.60 (.34)	0.10 (.44)
Student Emotional State (CESD Depression)	-.02 (.07)	-.02 (.22)	0.21 (.21)	-.54 (.23)**

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Global Outcome Expectancy

The first multiple regression model in Table 5.6 was found not to be a statistically significant predictor of global outcome expectancy ($F(4, 67) = .24$, $p = .92$). With an R^2 of .01, this multiple regression with four types of learning experiences accounted for less than 2% of the variance in global outcome expectancy. None of the four learning experiences were significantly related to global outcome expectancy among Women of Color in STEM majors.

Intrinsic-Goal Expectancy

The second regression model in Table 5.6 was also found not to be a significant predictor of intrinsic-goal expectancy ($F(4, 46) = .36$, $p = .36$). With an R^2 of .03, this multiple regression with four types of learning experience variables accounted for about 3% of the variance in intrinsic-goal expectancy. The regression findings reveal that none of the four learning experiences were significantly related to intrinsic-goal expectancy among Women of Color in STEM majors.

Organizational-Goal Expectancy

The third multiple regression model in Table 5.6 was found not to be a significant predictor of organizational-goal expectancy ($F(4, 46) = .26$, $p = .11$). With an R^2 of .11, this multiple regression with four learning experiences predictors accounted for about 11% of the variance for organizational-goal-expectancy among Women of Color in STEM majors. The regression findings indicate that none of the four learning experiences were related to organizational-goal-expectancy among undergraduate Women of Color in STEM majors.

Societal-Goal Expectancy

The fourth multiple regression model in Table 5.6 was also found not to be a significant predictor of societal-goal expectancy ($F(4, 69) = 1.681$, $p = .164$). With an R^2 of .089, this multiple regression with four learning experience predictors accounted for about 9% of the variance for societal-goal expectancy. Mentor encouragement, vicarious peer learning, nor academic mastery, were significantly related to societal-goal expectancy. However, emotional state was statistically significant related to societal-goal expectancy. Student emotional state had a statistically negative relationship to social-goal expectancy, suggesting that Women of Color with low emotional / affective states may have high motivation to persistence in STEM to work on societal concerns.

Research Question 3: How do intervention-based experiences, prior learning experiences and socio-cognitive motivation predictors collectively predict STEM persistence plans among Women of Color?

The third research question was designed to better understand how intervention-based experiences, prior learning experiences, and socio-cognitive motivation, together, predict successful STEM persistence plans for Women of Color in STEM majors. The specific research question explores how learning experiences — mentor encouragement, vicarious peer learning, academic mastery, and emotional state — and socio-cognitive motivation predictors —STEM self-efficacy and outcome expectations — together, predict STEM persistence plans among Women of Color in STEM majors.

Hypothesis 3a: Together, intervention-based and prior learning experiences, and socio-cognitive motivation predictors explain significant variance in STEM persistence plans among Women of Color. The first hypothesis related to this research question is that, together, intervention-based and prior learning experiences, STEM self-efficacy and outcome expectancies have significant relationships to STEM persistence plans for Women of Color in STEM majors. Table 5.7 presents the multiple regression findings for intervention-based and prior learning experiences, socio-cognitive motivation predictors, and three STEM persistence outcome variables – STEM Major Plans, Ph.D. Plans, and STEM Research Career Plans.

Table 5.7. Multiple Regression Analyses of the relationships of Intervention-based and Prior Learning Experiences, STEM Self-Efficacy, and Outcome Expectancies and STEM Persistence Plans among Women of Color

	STEM Persistence Plans		
	STEM Major Plans (N=33)	Ph.D. Plans (N=41)	STEM Research Career Plans (N=40)
Socio-Cognitive Motivation Predictors	*B (SE)*	*B (SE)*	*B (SE)*
(Constant)	-.41 (5.38)	6.56 (2.71)*	3.14 (3.54)
Intervention-Context Learning Experiences			
STEM Mentor Social and Verbal Persuasion	-0.03 (.79)	-0.28 (.40)	0.59 (.51)
Vicarious Intervention Peer Learning	0.004 (.50)	0.40 (.25)	0.17 (.32)
STEM Academic Mastery (Cum. GPA)	-0.73 (1.12)	0.04 (.52)	-0.73 (.68)
Student Emotional State (CESD Depression)	0.17 (.63)	-0.64 (.29)*	-0.04 (.38)
Multidimensional STEM Self-Efficacy	0.24 (.62)	0.73 (.31)*	0.10 (.40)
Outcome Expectancies			
Global Outcome Expectancy	1.73 (1.12)	-1.82 (.56)**	-0.24 (.72)
Intrinsic-Goal Expectancy	-0.97 (.48)	0.38 (.22)	-0.40 (.29)
Organizational-Goal Expectancy	0.44 (.58)	-0.01 (.24)	-0.13 (.32)
Societal-Goal Expectancy	0.10 (.51)	-0.44 (.25)	0.91 (.33)**

Note. STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,* 2) *Pretty certain will not,* 1) *Completely certain will not*

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

STEM Major Plans

The socio-cognitive motivation predictors are the same as in research question 1, with the addition of four learning experiences. The overall regression equation for STEM major plans was found not to be significant ($F(9, 23) = 1.836$, $p = .116$), with an R^2 of .418. In this analysis, counter to my RSCCM, the results show that when learning experiences were added to the model, the effects of Intrinsic-goal expectancy and Societal-goal expectancy on STEM Major Plans were minimized.

Ph.D. Plans

I conducted a similar multiple linear regression using the same predictor variables but focusing on persistence plans to pursue a doctoral degree. The overall regression equation was found to be significant ($F(9, 31) = 2.715$, $p < .05$), with an R^2 of .441, accounting for about 44% of the variance for Ph.D. explained by learning experiences, STEM self-efficacy and outcome expectancies. In this regression analysis, the effect of STEM self-efficacy and Global outcome expectancy on Ph.D. plans remained the same when learning experiences were added to the model. The effect of Intrinsic-goal expectancy on Ph.D. plans was minimized when learning experiences were added to the model. Additionally, emotional state emerged as a significant predictor of Ph.D. plans, while the other learning experiences — mentor encouragement, vicarious peer learning, and academic mastery — did not. Emotional state was negatively related, suggesting that Women of Color with higher emotional depressive states may be less likely to pursue a Ph.D.

STEM Research Career Plans

As shown in Table 5.7, a similar multiple regression was conducted using the same predictor variables with the addition of learning experiences to explain Women of Color plans to pursue a STEM research career. The overall regression equation was found to be significant ($F(9, 30) = 2.451$, $p < .05$), with an R^2 of .424, suggesting that about 42% of the variance for STEM research career plans among Women of Color in STEM majors can be explained by learning experiences, STEM self-efficacy and outcome expectancies. In support of my RSCCM, when learning experiences were added to the model, the effect of Societal-goal expectancy on STEM research career plans remained the same.

Hypothesis 3b: Specific societal-goal expectancies operate independently of other socio-cognitive motivation predictors, intervention-based experiences, and prior learning experiences among Women of Color in STEM majors. Figure 5.1 compares how Women of Color in this study rated three specific societal-goal expectancies — *community uplift expectancy, economic mobility expectancy, and social status expectancy*. The three ratings indicate how much these Women of Color, in STEM majors, expect that a STEM career will best enable them to achieve community uplift, economic mobility, and social status goals. As illustrated in Figure 5.1, Women of Color in STEM majors mostly expect that a STEM career will best enable them to achieve community uplift (100%), followed by economic mobility (90%) and social status (47%).

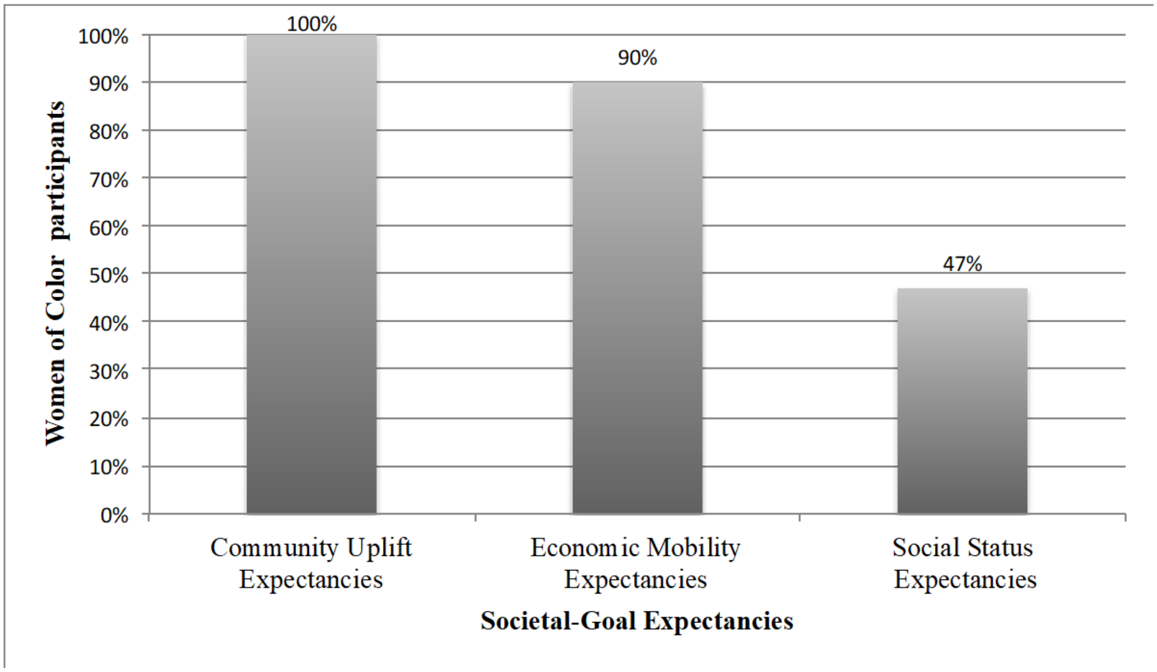


Figure 5.1. Specific Societal Goal Expectancies among Women of Color

Guided by expectancy-value theory, the second hypothesis related to this research question is that these three specific societal-goal expectancies that Women of Color bring to STEM contexts are unrelated to their other socio-cognitive motivation predictors and learning experiences in the RSCCM. To evaluate this hypothesis, Table 5.8 illustrates the zero-order correlations between the three societal-goal expectancies and other socio-cognitive motivation predictors — outcome expectancies and STEM self-efficacy — and intervention-based and prior learning experiences. In support of hypotheses 3b, the non-significant correlations reveal that the three societal-goal expectancies may operate independently of other socio-cognitive motivation predictors and learning experiences among Women of Color in STEM majors. First, the lack of a correlation for community uplift expectancy reflects the fact that 100 percent of Women of Color in the sample expected that a STEM career will best enable them to achieve community uplift.

The second column of correlation coefficients reveals that there is no statistically significant relationship between *economic mobility* expectancies and other socio-cognitive motivation predictors — intrinsic-goal expectancies, organizational-goal expectancies, global outcome expectancy, STEM self-efficacy — and learning experiences. Similarly, the third column of correlations also reveals that there is no statistically significant relationship between *social status expectancies* and other socio-cognitive motivation predictors and learning experiences among Women of Color in STEM majors.

Table 5.8. Correlations for Societal-Goal Expectancies, other Socio-Cognitive Motivation Predictors, and Intervention-based and Prior Learning Experiences

	Societal-Goal Expectancies		
Socio-Cognitive Motivation Predictors and Intervention-based Experiences	Community Uplift Expectancy	Economic Mobility Expectancy	Social Status Expectancy
Intrinsic-Goal Expectations			
a. How much can successful preparation for a PhD degree and research career help you in achieving self confidence and feelings of accomplishment?	-	-.04	.03
b. How much can successful preparation for a PhD degree and research career help you in achieving a chance to develop personal ideas and values?	-	-.05	-.09
c. How much can successful preparation for a PhD degree and research career help you in achieving greater awareness of yourself and the world?	-	-.15	-.03
Organizational-Goal Expectations			
d. How much can successful preparation for a PhD degree and research career help you in achieving admiration and respect of fellow students?	-	.05	-.02
e. How much can successful preparation for a PhD degree and research career help you in achieving praise and recognition from your teachers?	-	.11	-.06
f. How much can successful preparation for a PhD degree and research career help you in achieving credits towards a college degree?	-	-.01	.05
g. How much can successful preparation for a PhD degree and research career help you in achieving skills and knowledge for your chosen career?	-	-.11	.07
Global Outcome Expectancy	-	.00	-.16
Multidimensional STEM Self -Efficacy	-	.18	.00
Intervention-based Experiences	-		
STEM Mentor Social and Verbal Persuasion	-	.14	-.15
Vicarious Intervention Peer Learning	-	.22	-.08
STEM Academic Mastery (Cum. GPA)	-	.11	.12
Student Emotional State (CESD Depression)	-	.06	-.04

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

<u>Research Question 4</u>: How do Women of Color's own perceived STEM talents predict their STEM self-efficacy, outcome expectations, and STEM persistence plans?

Guided by the RSCCM, this research question focuses on the role of perceived STEM talents in the persistence plans among Women of Color in STEM. To explore this question, I focus on the *personal aspects* of perceived STEM talents as the concept of oneself developed over the course of life regarding their natural, specialized, and career-related talents. Perceived STEM talent is composed of self-assessments of one's natural talents and developing abilities, which may be STEM career-related. In addition to perceived STEM talents, Women of Color may also perceive they have other *salient career*-related natural talents. Women of Color in this sample were asked about their most salient talents and these open-ended responses were coded and themed into five career-related talents; STEM, Artistic, Athletic, Service, or Intellectual talents. Appendix C provides a description of the five career-related talents.

Hypothesis 4a: **Perceived STEM talents enhance STEM persistence plans among Women of Color.** The first hypothesis for research question 4 is that perceived STEM talents should have a positive relationship with STEM persistence plans. As presented in table 5.9, multiple regression was utilized to investigate the hypothesized relationship between perceived STEM talents and the three STEM persistence plans outcome variables — STEM Major Plans, Ph.D. Plans and STEM Research Career Plans.

Table 5.9. Multiple Regression Analyses of the relationships of Perceived STEM Talent Predictors and STEM Persistence Plans among Women of Color

	STEM Persistence Plans		
	STEM Major Plans	Ph.D. Plans	STEM Research Career Plans
	(N=101)	(N=116)	(N=118)
Perceived Natural Talents	*B (SE)*	*B (SE)*	*B (SE)*
(Constant)	2.81 (.27)***	3.89 (.14)***	2.42 (.18)***
Perceived STEM Natural Talent	1.44 (.99)	0.94 (.43)*	1.25 (.58)*
Perceived Artistic Natural Talent	0.55 (.41)	0.43 (.20)*	0.22 (.27)
Perceived Athletic Natural	0.07 (.73)	0.41 (.35)	0.28 (.47)
Perceived Service Natural Talent	2.19 (1.93)	0.11 (1.01)	2.58 (1.37)
Perceived Intellectual Natural Talents[a]	—	—	—

Note. [a]Constant variable, unable to be included in analyses.
STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,* 2) *Pretty certain will not,* 1) *Completely certain will not*
* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

STEM Major Plans

As shown in Table 5.9 and in contrast to my RSCCM, perceived STEM talents is unrelated to STEM major persistence plans for Women of Color in STEM majors. Moreover, the overall regression equation for STEM major plans was found not to be significant ($F(4, 96) = 1.10$, $p = .356$), with an R^2 of .044, accounting for about 5% of the variance for STEM major plans among Women of Color in STEM majors.

Ph.D. Plans

In support of hypothesis 4a, perceived STEM talent is significantly related to Ph.D. plans among Women of Color in STEM majors. Surprisingly, perceived artistic talents were also significantly related to Ph.D. plans. Consistent with my RSCCM, this finding suggests that Women of Color in STEM majors who have higher perceptions of having talents in STEM may more often plan to persist toward a Ph.D. degree. However, the overall regression equation was not significant ($F(4, 111) = 1.978$, $p = .103$), with an R^2 of .067, accounting for about 7% of the variance for Ph.D. plans for Women of Color in STEM majors explained by perceived natural talents.

STEM Research Career Plans

In support of hypothesis 4a, perceived STEM talents is also significantly related to STEM research career plans among Women of Color in STEM majors. However, neither of the other career-related talents – Artistic, Athletic, and Service – were related to STEM research career plans. As shown in Table 5.9, the overall regression equation was not significant ($F(4, 113) = 1.963$, $p = .105$), with an R^2 of .065, suggesting that about 7% of the variance for STEM research career plans among Women of Color in STEM majors is explained by perceived natural talents.

Overall, two out of three persistence measures were positively related to perceived STEM talent. Perceived Artistic talent was the only non-STEM talent associated with Ph.D. plans.

Hypothesis 4b: Perceived STEM talent should have a stronger relationship to intrinsic-goal expectancy than other traditional socio-cognitive motivation predictors among Women of Color. To investigate this hypothesis, Table 5.10 presents findings from a series of linear regressions that investigate the relationship between perceived STEM talents and five traditional socio-cognitive motivation predictors —STEM self-efficacy, Global outcome expectancy, Intrinsic-goal expectancy, Organizational-goal expectancy, and Societal-goal expectancy. Drawing on expectancy-value theory, the focus on self-assessments of one's natural talents and ability is more consistent with intrinsic goal expectancies than other core socio-cognitive motivation predictors. The following sections highlight related regression findings on the relationship between perceived STEM talents, intrinsic goal expectancies and other traditional socio-cognitive motivation predictors among Women of Color in STEM majors.

Table 5.10. Regression Analysis of the relationship of Perceived STEM Talent and Socio-Cognitive Predictors among Women of Color

	Socio-Cognitive Motivation Predictors				
	STEM Self-Efficacy	Global Outcome Expectancy	Intrinsic-Goal Expectancy	Organizational-Goal Expectancy	Societal-Goal Expectancy
Perceived Natural Talent	(N=80) *B (SE)*	(N=80) *B (SE)*	(N=52) *B (SE)*	(N=52) *B (SE)*	(N=80) *B (SE)*
(Constant)	4.01 (0.75)***	3.22 (.04)***	4.53 (.11)***	4.2 (.11)***	1.48 (.14)***
Perceived STEM Natural Talent	-0.23 (.25)	-0.06 (.14)	-0.86 (.35)*	-0.70 (.36)	0.52 (.49)

Note. STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,* 2) *Pretty certain will not,* 1) *Completely certain will not*
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Perceived STEM Talent and Intrinsic Goal Expectancy

In support of hypothesis 4b, the regression equation of perceived STEM talent and intrinsic-goal expectancy was found to be significant ($F(1, 50) = 6.061$, $p < .05$), with an R^2 of .108, accounting for about 11% of the variance for intrinsic-goal expectancies explained by perceived STEM talent. However, surprisingly, the results indicate that perceived STEM talent and intrinsic-goal expectancy were negatively related, suggesting that Women of Color with high perceptions of their STEM talents may be less likely to perceive that a Ph.D. and STEM research career will help them achieve their intrinsic goals. As hypothesized, perceived STEM talent was unrelated to the other traditional socio-cognitive motivation predictors among Women of Color in STEM majors. More specifically, as shown in Table 5.10, perceived STEM talent was found not to be significantly related to STEM self-efficacy, Global outcome expectancy, Organizational-goal expectancy, nor Societal-goal expectancy

Research Question 5: How do perceived socio-cultural context predictors (role-strain barriers and adaptive role supports) predict STEM persistence plans for Women of Color?

The fifth research question was designed to better understand how socio-cultural contextual motivation predictors — role-strain barriers and adaptive role supports — predict STEM persistence plans among Women of Color in STEM majors. The specific research question explores the relationships of socio-cultural contextual factors — Perceived Discrimination, Low Income status, Perceived Racial Socialization, and Racial/Ethnic majority campus — with STEM persistence plans among Women of Color.

Hypothesis: Role strain-barriers and adaptive role supports — both subjective and objective — predict STEM persistence plans among Women of Color. The hypothesis related to this research question is that contextual role-strain-barriers and adaptive role supports predict STEM persistence plans among Women of Color. I employed multiple linear regressions to examine the relationships among four socio-cultural contextual motivation predictor variables (Perceived Discrimination, Low Income status, Perceived Racial Socialization, and attending a Racial/Ethnic majority campus) and three STEM Plans outcome variables (STEM Major Plans, Ph.D. Plans, and STEM Research Career Plans). More specifically, I utilized regression models to examine how socio-cultural contextual role strain-barriers and adaptive role supports predict STEM persistence plans for Women of Color in STEM majors.

The next section will discuss each regression model to address the hypothesis and how the socio-cultural contextual predictors account for variance in STEM career plans among Women of Color in STEM majors. Table 5.11 reveals the regression analyses for socio-cultural contextual motivation predictors and STEM persistence plans for Women of Color. The following sections detail the results for each STEM persistence plan.

Table 5.11. Multiple Regression Analyses of the relationships of Socio-Cultural Contextual Predictors and STEM Persistence Plans among Women of Color

	STEM Persistence Plans		
	STEM Major Plans	Ph.D. Plans	STEM Research Career Plans
	(N=63)	(N=74)	(N=74)
Socio-Cultural Contextual Motivation Predictors	*B (SE)*	*B (SE)*	*B (SE)*
(Constant)	1.14 (1.03)	3.96 (.55)**	1.38 (.67)*
Role-Strain Barriers			
Perceived Discrimination (Racial/Gender)	1.02 (.55)	0.07 (.29)	0.78 (.36)*
Low Income (Pell Grant Eligibility)	0.56 (.53)	0.11 (.28)	-0.14 (.34)
Adaptive Role Supports			
Racial Socialization	0.19 (.51)	0.20 (.27)	0.02 (.33)
Racial/Ethnic Majority Campus[a]	-0.35 (.53)	-0.31 (.28)	-0.08 (.34)

Note. [a]Student's Home Campus
STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,* 2) *Pretty certain will not,* 1) *Completely certain will not*
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

STEM Major Plans

The regression equation for STEM major plans was found not to be significant ($F(4, 58) = 1.019$, $p = .41$), with an R^2 of .07, accounting for about 7% of the variance for STEM major plans explained by socio-cultural contextual role-strain-barriers and adaptive role supports motivation predictors. In contrast to my RSCCM, Perceived Discrimination, Low Income status, Perceived Racial Socialization, and attending a Racial/Ethnic majority campus were unrelated to STEM major plans among Women of Color in STEM majors.

Ph.D. Plans

The regression equation for Ph.D. plans was found not to be significant ($F(4, 59) = .386$, $p = .818$), with an R^2 of 0.02, accounting for about 2% of the variance for Ph.D. plans explained by socio-cultural contextual role-strain-barriers and adaptive role supports motivation predictors. In contrast to my RSCCM, Perceived Discrimination, Low Income status, Perceived Racial Socialization, and attending a Racial/Ethnic majority campus were unrelated to Ph.D. plans among Women of Color in STEM majors.

STEM Research Career Plans

The regression equation for STEM research career plans was found not to be significant ($F(4, 69) = 1.452$, $p =.226$), with an R^2 of .078, accounting for about 8% of the variance for STEM research career plans explained by socio-cultural contextual role-strain-barriers and adaptive role supports motivation predictors. In contrast to my RSCCM, Low Income status, Perceived Racial Socialization, and attending a Racial/Ethnic majority campus were unrelated to STEM Research Career plans among Women of Color in STEM majors. In support of my RSCCM, Perceived Discrimination was significantly related to STEM research career plans for Women of Color. This finding suggests that as Women of Color plan to pursue high achievement goals (in this current study have, intentions to pursue a research career in STEM) they may often perceive forms of discrimination (e.g., racial/ethnic, gender).

For the analyses overall in the current study, results show that only barriers, and not supports, are predictive and only predictive of STEM research career plans.

Research Question 6: How do multiple socio-cognitive motivation predictors, together with traditional predictors of persistence, help to further explain STEM persistence plans for Women of Color?

Hypothesis 6a: In addition to STEM self-efficacy, multiple socio-cognitive predictors help to further explain STEM persistence plans among Women of Color. Table 5.12 shows the regression analyses for the significant socio-cognitive motivation predictors and STEM persistence plans for Women of Color from the analyses of research questions 1-5. The following sections detail the results for each STEM persistence plan.

Table 5.12. Full Regression Model

	STEM Persistence Plans		
	STEM Major Plans	Ph.D. Plans	STEM Research Career Plans
	(N=31)	(N=37)	(N=36)
Socio-Cognitive Motivation Predictors[a]	*B (SE)*	*B (SE)*	*B (SE)*
(Constant)	-1.73 (4.69)	5.88 (2.18)*	0.38 (2.77)
Multidimensional STEM Self-Efficacy	0.002 (.74)	0.35 (.34)	-0.22 (.43)
Outcome Expectancies			
Global Outcome Expectancy	1.58 (1.12)	-1.79 (.53)**	-0.10 (.67)
Intrinsic-Goal Expectancy	-0.79 (.35)*	0.58 (.16)**	-0.39 (.21)
Societal-Goal Expectancy	0.98 (.51)	-0.20 (.25)	0.76 (.31)*
Intervention-Based Experiences			
STEM Mentor Social and Verbal Persuasion	-0.14 (.95)	0.57 (.42)	0.76 (.53)
Student Emotional State (CESD Depression)	0.24 (.69)	-0.57 (.32)	-0.25 (.41)
Perceived STEM/Natural Talents	0.55 (1.41)	0.32 (.51)	0.03 (.64)
Perceived Discrimination (Racial/Gender)	0.69 (.77)	-0.32 (.36)	0.73 (.46)
	R^2= .40	R^2= .52	R^2= .48

Note. [a]Socio-Cognitive Motivation Predictors and STEM persistence plans had significant relationships in earlier analyses.
STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,* 2) *Pretty certain will not,* 1) *Completely certain will not*
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

STEM Major Plans

The regression equation for STEM major plans was found not to be significant ($F(8, 22) = 1.83$, $p = .13$), with an R^2 of 0.40, accounting for about 40% of the variance for STEM major plans explained by the socio-cognitive motivation predictors. However, Intrinsic-goal expectancy had a significant relationship to STEM major plans among Women of Color in STEM majors.

Ph.D. Plans

The regression equation for Ph.D. plans was found to be significant ($F(8, 28) = 3.82$, $p < .01$), with an R^2 of 0.522, accounting for about 52% of the variance for Ph.D. plans explained by the socio-cognitive motivation predictors. Global outcome expectancy had a significant relationship to Ph.D. plans among Women of Color in STEM majors. However, this relationship is negative. Intrinsic-goal expectancy had a statistically significant positive relationship to Ph.D. plans.

STEM Research Career Plans

The regression equation for STEM research career plans was found to be significant ($F(8, 27) = 3.10$, $p < .05$), with an R^2 of 0.478, accounting for about 48% of the variance for STEM research career plans explained by the socio-cognitive motivation predictors. Societal-goal expectancy had a statistically significant positive relationship to STEM research career plans among Women of Color in STEM majors.

Hypothesis 6b: Multiple STEM socio-cognitive motivation predictors, along with traditional predictors of persistence, help to further explain STEM persistence plans among Women of Color. Before conducting a multivariate analysis examining how other predictors related to STEM persistence plans among Women of Color, it was important to examine the correlations between possible covariates and the outcomes. These other possible covariate predictor variables are from the higher education literature suggesting their effect on college student persistence. Possible covariates are mother's education background, participant age, race/ethnicity, intervention vs no intervention, year in college, grades in terms of mostly A's, B's or C's, and the type of STEM major. The correlations are presented in Table 5.13.

Table 5.13. Correlations between Traditional Persistence Predictors and STEM Persistence Plans among Women of Color

	STEM Persistence Plans		
Predictors	STEM Major Plans	Ph.D. Plans	STEM Research Career Plans
Mother's Education Background	.09	.060	.103
Participant's Age	-.16	-.02	-.04
Race/Ethnicity	-.13	.07	-.01
Intervention (SROP/SROP-Like vs. None)	.34**	-.09	.25*
Student Year in College	-.21	.14	-.12
Grades (Cum. GPA) A, B, or C	-.06	.09	-.03
STEM Major Field[a]	-0.42**	.08	-0.44**

Note. [a]Student's major is in Biomedical/Behavioral/Social Sciences or Other Basic and Applied Sciences.
STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,* 2) *Pretty certain will not,* 1) *Completely certain will not*
$*p \leq .05$, $**p \leq .01$, $***p \leq .001$

As shown in Table 5.13, intervention vs no intervention, and STEM major type had significant correlations with STEM major plans and STEM research career plans. Intervention was positively correlated with STEM major plans (r = .34, p < .01) and positively correlated with STEM research career plans (r = .25, p < .05). STEM major type was negatively correlated with STEM major plans (r = -.42, p < .01) and STEM research career plans (r = -.44, p < .01).

To better understand the effects of socio-cognitive motivation on STEM persistence plans among Women of Color in STEM majors, it was necessary to examine how their influences may have changed as other significant measures, intervention vs no intervention and STEM major type, were considered in the analyses. While other measures may be considered, Table 5.13 indicates that intervention vs no intervention and STEM major type have a significant relationship to the outcome variables, and therefore only these two variables will be included as covariates. The results are included in Table 5.14, Models 1 and 2. The following sections detail the results of the successive models and how they account for variance for each STEM persistence plan

Table 5.14. Regression of STEM Persistence Plans on Socio-Cognitive Motivation Predictors and Selected Covariates

	STEM Persistence Plans					
	STEM Major Plans		Ph.D. Plans		STEM Research Career Plans	
	Model 1 (N=31)	Model 2 (N=31)	Model 1 (N=37)	Model 2 (N=37)	Model 1 (N=36)	Model 2 (N=36)
Socio-Cognitive Motivation Predictors	*B (SE)*	*B (SE)*	*B (SE)*	*B (SE)*	*B (SE)*	*B (SE)*
(Constant)	-1.73 (4.69)	-2.33 (5.00)	5.88 (2.18)*	6.40 (2.27)**	0.38 (2.77)	1.72 (2.70)
Multidimensional STEM Self-Efficacy	0.002 (.74)	-0.23 (.81)	0.35 (.34)	0.26 (.39)	-0.22 (.43)	-0.71 (.47)
Outcome Expectancies						
Global Outcome Expectancy	1.58 (1.12)	1.90 (1.10)	-1.79 (.53)**	-1.81 (.54)**	-0.10 (.67)	-0.13 (.63)
Intrinsic-Goal Expectancy	-0.79 (.35)*	-0.68 (.34)	0.58 (.16)**	0.56 (.17)**	-0.39 (.21)	-0.32 (.20)
Societal-Goal Expectancy	0.98 (.51)	0.81 (.51)	-0.20 (.25)	-0.14 (.25)	0.76 (.31)*	0.73 (.29)*
Intervention-Based Experiences						
STEM Mentor Social and Verbal Persuasion	-0.14 (.95)	0.66 (1.02)	0.57 (.42)	0.56 (.45)	0.76 (.53)	1.20 (.53)*
Student Emotional State (CESD Depression)	0.24 (.69)	-0.11 (.69)	-0.57 (.32)	-0.55 (.33)	-0.25 (.41)	-0.40 (.39)
Perceived STEM/Natural Talents	0.55 (1.41)	0.90 (1.38)	0.32 (.51)	0.46 (.52)	0.03 (.64)	-0.32 (.62)
Perceived Discrimination (Racial/Gender)	0.69 (.77)	0.41 (.77)	-0.32 (.36)	-0.25 (.36)	0.73 (.46)	0.61 (.43)
Significant Covariates						
Intervention (SROP/SROP-Like vs. None)		0.26 (1.45)		-0.60 (.52)		-0.57 (.62)
STEM Major Field[a]		-1.87 (1.01)		0.33 (.42)		-1.19 (.49)*
Coefficient of Determination	R^2= .40	R^2= .49	R^2= .52	R^2= .56	R^2= .48	R^2= .58

Note. [a]Student's major is in Biomedical/Behavioral/Social Sciences or Other Basic and Applied Sciences.
STEM Persistence Plans Scale: 5) *Completely certain will,* 4) *Pretty Certain will,* 3) *Some possibility will,*
2) *Pretty certain will not,* 1) *Completely certain will not*
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

STEM Major Plans

Model 1 in the regression includes predictors for socio-cognitive motivation, accounting for about 40% of the variance in STEM major plans. Model 2 adds two covariates that had a statistically significant correlation with STEM Major Plans and STEM Research Career Plans to the analysis. This model includes measures for intervention participation (Intervention SROP/SROP-Like vs. None) and type of STEM major (STEM major field). In Model 2, both the socio-cognitive motivation predictors and the covariates accounted for about 49% of the variance in STEM major plans. The effect of Intrinsic-goal expectancy on STEM major plans is minimized when the covariates are added to the model.

Ph.D. Plans

Model 1 in the regression includes predictors for socio-cognitive motivation, accounting for about 52% of the variance in Ph.D. plans. Model 2 adds two covariates that had a statistically significant correlation with STEM Major Plans and STEM Research Career Plans to the analysis. This model includes measures for intervention participation and type of STEM major. In Model 2, both the socio-cognitive motivation predictors and the covariates accounted for about 56% of the variance in Ph.D. plans. The effect of Global outcome expectancy and Intrinsic-goal expectancy on Ph.D. plans remains the same when the covariates are added to the model.

STEM Research Career Plans

Model 1 in the regression includes predictors for socio-cognitive motivation, accounting for about 48% of the variance in STEM research career plans. Model 2 adds two covariates that had a statistically significant correlation with STEM Major Plans and STEM Research Career

Plans to the analysis. This model includes measures for intervention participation and type of STEM major. In Model 2, both the socio-cognitive motivation predictors and the covariant variables accounted for about 58% of the variance in STEM research career plans. The effect of Societal-goal expectancy on STEM research career plans remains the same when the covariates are added to the model. However, STEM mentor social and verbal persuasion is statistically significant when the covariates are added to the model. The covariate, STEM major field, (type of STEM major) has a negative significant relationship to STEM research career plans.

Overall, in these analyses, the covariates are not related to STEM persistence plans with the exception of STEM major field with STEM research career plans.

Chapter 6 Discussion

This study reformulates social cognitive career theory by going beyond the conventional emphasis on self-efficacy to provide new insight into the multiple socio-cognitive motivation predictors of STEM persistence plans among undergraduate Women of Color (African American and Hispanic American). Building on expectancy-value and role-strain theories, my reformulated socio-cognitive career model (RSCCM) was developed to better understand pivotal motivational factors that empower some Women of Color, despite facing systemic barriers, to persist in their undergraduate STEM majors, pursue Ph.D. degrees and plan STEM research careers. This theory-driven study makes unique contributions to existing higher education literature on college persistence by further clarifying multiple socio-cognitive motivation predictors of STEM persistence plans among Women of Color during the undergraduate-to-graduate studies transition.

The RSCCM and related study findings have important implications for theory, research and practice. First, RSCCM findings have theoretical significance for better understanding the multiple sources of motivation in STEM persistence decisions among Women of Color, especially during advanced stages of career development. Second, findings have important implications for future research to further clarify RSCCM propositions on larger and more diverse samples. Finally, RSCCM findings have policy relevance for informing strengths-based strategies that promote STEM persistence among

Women of Color by reinforcing the multiple socio-cognitive motivational strengths that they bring to the BTAA-SROP and other pipeline intervention settings.

Extrapolating from Bandura's seminal theory and research in psychology, traditional SCCT places a major focus on the explanatory power of self-efficacy (e.g., Bandura, 1977, 1986, 1997). In addition to self-efficacy, my Reformulated Socio-Cognitive Career Model (RSCCM) also emphasizes the importance of path-goal outcome expectancies, strong faculty mentoring, perceived STEM talents, and perceived socio-cultural contexts as important sources of socio-cognitive motivation and persistence for Women of Color in STEM fields. Within SCCT, self-efficacy is conceptualized as the pivotal socio-cognitive factor that guides interactions between individuals and their environment, social learning, and other socio-cognitive appraisals, to better explain career-related motivation and behaviors. A central tenet is that how individuals evaluate and interpret their own experiences and performance informs and modifies their self-efficacy, which in turn, motivates achievement-related behaviors and persistence. The RSCCM in this study supports investigating other pivotal socio-cognitive motivational and socio-cultural contextual mechanisms within strengths-based STEM pipeline interventions designed to promote STEM major persistence, advanced Ph.D. studies and faculty research careers among underrepresented undergraduate students.

Summary of Major Study Findings

Based on a larger NIH-NIGMS funded study, multiple regression analyses were conducted on panel survey data from 179 Women of Color who applied to the Summer

Research Opportunity Program (SROP) at 14 major universities affiliated with the Big Ten Academic Alliance (BTAA). Guided by the RSCCM, several hypotheses were tested to explore the role of STEM self-efficacy, STEM outcome expectancies, perceived STEM talents, STEM intervention-based appraisals, and perceived barriers and supports on STEM persistence plans. Findings indicate that in addition to self-efficacy, path-goal outcome expectations, strong faculty mentoring and perceived STEM talents were significant predictors of higher STEM persistence plans. Surprisingly, perceived discrimination was associated with higher rather than lower STEM persistence plans, and also moderated the relationship between self-efficacy and STEM persistence plans.

The major findings in this study of socio-cognitive motivation and STEM persistence plans among Women of Color provide significant support for the ***five major propositions*** postulated by my RSCCM: (1) In addition to student's ***self-efficacy***, both ***intrinsic*** and ***community uplift outcome expectancies*** were found to be significant socio-cognitive motivation predictors of STEM persistence plans; (2) a student's perceptions of intervention-based experiences — specifically, faculty mentor verbal/social encouragement — was also a significant predictor of STEM persistence plans and positively reinforced STEM self-efficacy; (3) a student's self-appraisal that they have ***STEM talents*** was significantly related to both intrinsic outcome expectancies and STEM persistence plans.

With regard to my fourth RSCCM proposition, perceptions of the ***socio-cultural context*** — including barriers (low income status) and supports (racial socialization, racial/ethnic majority campus) — were not directly related to STEM persistence plans.

However, one socio-cultural contextual barrier, perceptions of discrimination, was significantly related to STEM research career plans. Furthermore, some significant interaction relationships (i.e., STEM self-efficacy with perceived discrimination and STEM talents with perceived discrimination) with in a deeper analysis suggest that such socio-cultural perceptions may impact STEM persistence under certain conditions. In support of the fifth RSCCM proposition, my analyses also revealed that various socio-cognitive predictors explained more variance in STEM persistence plan than traditional predictors of college persistence including college GPA, parents' SES, campus racial composition, and socio-demographic factors.

Self-efficacy and outcome expectancies. My findings showed that STEM self-efficacy and various outcome expectancies have separate relationships to STEM persistence plans among Women of Color; these results support a basic motivational proposition guiding my RSCCM. While STEM self-efficacy was a significant predictor the of STEM persistence plans, on average, the Women of Color in this study were more strongly motivated by two path-goal outcome expectancies — intrinsic goal and societal-goal expectancies. These findings are in contrast to traditional SCCT, which suggests that outcome expectations primarily mediate effects of self-efficacy on career outcomes and should not have strong separate effects (Betz & Hackett, 1981; Gainor, 2006; Hackett, 1995; Hackett & Betz, 1981; Lent, 2005; Lent & Brown & Larkin, 1984, 1986, 1987).

For Women of Color at this advanced stage of STEM career development, outcome expectancies were more significant than self-efficacy as a source of STEM motivation and persistence plans. To understand persistence decisions beyond the high school and early undergraduate years, the current study examined persistence among Women of Color who applied to SROP during their undergraduate-to-graduate studies transition. Students apply to SROP primarily because of their high levels of academic, research and STEM career self-efficacy, and strong interest in faculty research careers. Therefore, this lack of variance or truncation of range may be one possible reason for the relatively low explanatory power of STEM self-efficacy in the present study. For these Women of Color, their STEM persistence plans were more strongly motivated by outcome expectancy beliefs that STEM persistence was a necessary pathway to highly valued intrinsic and societal goals.

These RSCCM findings on the importance of intrinsic-goal and societal-goal expectancies for STEM persistence plans among Women of Color are more consistent with the broader EVT literature that consistently shows how self-efficacy and outcome expectancies have independent effects on a broad range of achievement-related motivation and behavioral outcomes (e.g. Bowman, 1977; Eccles, 1983, 2009; Wigfield et al., 2009; Feather, 1982; Lawler, 1997). However, in this sample, there was no support for the EVT multiplicative hypothesis that STEM self-efficacy and outcome expectancies interact to further motivate STEM persistence plans among Women of Color in this sample. In addition to examining the undergraduate-to-graduate studies transition, future research should further clarify the joint effect of self-efficacy and outcome expectancies on STEM persistence among Women of Color within strengths-based interventions at other career development transition points — middle school-to-high school, high school-to-college, graduate-to-postdoctoral students, and postdoctoral studies-to-research careers. By doing so, we may better understand the various socio-cognitive motivation factors that have greater significance to STEM career outcomes during different junctures within the K-12 through career pipeline among Women of Color in STEM.

Perceptions of intervention-based experiences. Findings that Women of Color undergraduates' perceptions of ***intervention-based experiences*** — social/verbal encouragement from faculty mentors — was a significant predictor of STEM self-efficacy and persistence plans also provided some preliminary support for the second proposition in my RSCCM. This supportive RSCCM finding is also consistent with EVT-related research on the influence of organizational supervisors and peer groups on motivation and performance (e.g., Lawler, 1997), and the multiple social learning sources of self-efficacy (e.g., Bandura, 1977).) This, within STEM intervention settings, strong faculty support may be especially important to student motivation and persistence (e.g. Lawler, 1994), particularly among Women on Color in STEM.

Building on Bandura's basic socio-cognitive theory, traditional SCCT focuses on four major social learning sources of self-efficacy beliefs, with the first two having particular relevance for understanding STEM intervention-based sources of socio-cognitive motivation: (1) social/verbal encouragement (e.g., faculty mentors); (2) vicarious learning experiences (e.g., SROP peers); (3) mastery experiences based on a person's own successful performance accomplishments (e.g., GPA) and (4) emotional arousal—including a person's negative affective or physical states (e.g., depressive affect). Beyond findings on the socio-cognitive motivational significance of faculty mentor support, I found no support for the second RSCCM intervention-based hypothesis that vicarious learning from SROP-peers is a significant predictor of both STEM self-efficacy and persistence plans. For my small sample of high-achieving Women of Color STEM majors, I also found no evidence that past mastery experience (cumulative GPA) was a significant predictor of either the multidimensional measure of STEM self-efficacy or persistence plans. Interestingly, going beyond past EVT-related findings, I did find that the emotional/affective state (depressive affect) of Women of Color had a significant negative relationship to their STEM societal-goal expectancy.

Role of perceived STEM talents. In support of my RSCCM, Women of Color's perceived STEM talents were significantly related to both intrinsic-goal expectancies and STEM persistence plans, particularly Ph.D. plans and STEM research career plans among Women of Color. These RSCCM findings suggest that Women of Color who perceive that they have STEM talents have higher motivation to persist in STEM careers during the undergraduate-to-graduate studies transition. However, surprisingly, perceived STEM talents and intrinsic-goal expectancy were negatively related, indicating that Women of Color who perceive that they have STEM talents are less likely to believe that a STEM career is necessary to achieve their intrinsic goals of self-confidence, self-development, and self-awareness.

Going beyond conventional SCCT studies, my finding that perceived STEM talents was significantly related to STEM persistence plans is consistent with basic EVT, which supports the motivational importance of self-efficacy, various outcome expectancies, as well as other ***self-appraisals*** such as self-concept, self-identity, and self-attributions (e.g., Eccles. 1983; Rosenberg, 1965; Weiner, 1973). For example, the seminal work of Rosenberg (1965) on self-esteem suggests that in contrast to self-efficacy, one’s perceived STEM talents might reflect a broader concept of *STEM self-identity* that includes one's general beliefs one’s own natural talents, abilities, and skills. STEM self-efficacy is similar because it involves one's beliefs about their abilities and competence, but is more specific to certain domains under observation, such as math, science, engineering, or domain-specific beliefs about similar skill-based courses of action such as STEM-related academic, research, and career skills. RSCCM findings on perceived STEM talents and intrinsic goal expectancies are also consistent with a related SCCT conceptual extension developed by Byars and Hackett (1998). Similar to STEM career interests, this related SCCT extension suggests that perceived STEM talents may mediate the impact of race/gender status, background affordances, and proximal contextual factors on career-related outcomes among Women of Color.

My RSCCM findings on perceived STEM talents in this study represent one mechanism by which perceptions of having STEM talents influence STEM career-related goals among Women of Color. As a perceived socio-cognitive strength, a better understanding of perceived STEM talents and STEM persistence plans would provide new insights on the STEM-related self-appraisals, interests, goals, and values among Women of Color pursuing STEM careers. Future research using qualitative data would provide deeper exploration into the possible, various constructions of this concept and its meaning from the perspective among Women of Color. Qualitative studies would also help to better understand how perceived STEM talents are related to intrinsic path-goal expectancies as well as STEM persistence decisions and career outcomes among Women of Color and other underrepresented groups.

Role of the socio-cultural context. The exploratory findings in this study fail to fully support my RSCCM proposition that perceptions of the broader s***ocio-cultural context*** — including barriers (low income status) and supports (racial socialization, racial/ethnic majority campus) — are directly related to STEM persistence plans among Women of Color. However, study findings did support that perceived racial/gender discrimination was significantly related to STEM research career plans. In a deeper analysis more consistent with role strain and adaptation studies, some significant interaction relationships suggest more complex relationships between perceived discrimination, self-appraisals, and STEM persistence among students of color (e.g. Bowman, 1977; 2012; Burt, Williams, & Smith, 2018; Williams, 2014; Williams, Burt, & Hilton, 2016).

Future research with larger samples should further clarify how such complex interactions between perceived racial/gender discrimination and STEM self-efficacy may reveal how Women of Color mobilize socio-cognitive motivational strengths to overcome systemic barriers related to race/ethnic and gender inequalities. For example, in a deeper analysis, two interaction terms of perceived discrimination and STEM-Self-Efficacy, and perceived discrimination and perceived STEM talents were significantly related to STEM major plans for Women of Color. This suggests that, when of Women of Color face high contextual barriers (discrimination), stronger STEM self-efficacy and perceived STEM talents are more necessary to motivate persistence in STEM undergraduate majors. However, findings provide no empirical evidence to support the RSCCM proposition that parental racial socialization—as measure of perceived contextual support— promotes STEM persistence plans among Women of Color.

Significant RSCCM findings on the racial/gender discrimination by self-efficacy interaction relationships to STEM persistence plans are also consistent with an emerging socio-cognitive literature emphasizing the need to go beyond a narrow focus on self-efficacy to better understand the impact of socio-cultural barriers and supports in the career development of Women of Color (Byars & Hackett, 1998; Byars-Winston, et al., 2010; Byars-Winston & Foaud, 2008). Despite the primary focus on self-efficacy beliefs, these SCCT researchers have emphasized the importance of better understanding how self-efficacy *operates* with broader socio-ecological contextual factors including discriminatory barriers and cultural supports to determine career development outcomes.

Theoretical Implications: Toward a Reformulated Socio-Cognitive Career Model

In theoretical terms, my dissertation findings provided at least some support for the five major propositions postulated by my RSCCM: (1) in addition to a student's ***self-efficacy***, various ***outcome expectancies*** are also pivotal socio-cognitive motivation predictors of STEM persistence plans; (2) a student's perceptions of ***intervention-based experiences*** reinforce self-efficacy, outcome expectancies, and STEM persistence plans; (3) a student's self-appraisal that they have ***STEM talents*** is related to both intrinsic outcome expectancies and STEM persistence plans; (4) a student's perceptions of the s***ocio-cultural context*** — including barriers and supports — are significant socio-cognitive motivation predictors of STEM persistence plans; and, (5) together with traditional predictors of college persistence, multiple socio-cognitive motivation predictors help to further explain STEM persistence plans among Women of Color.

My dissertation findings that support these RSCCM propositions also help to fill three ***critical theoretical gaps*** in related literature on *college persistence*, *STEM intervention efficacy*, and *social cognitive career theory*. First, consistent with a growing strengths-based literature, these theory-driven findings also go beyond traditional college persistence studies on underrepresented students that focused primarily on either financial-aid or remediation of personal deficits by investigating the role of multiple socio-cognitive motivation predictors of college persistence plans (e.g., Bailey, 2015; Bowman, 2006, 2011, 2012; Hrabowski et al., 2002; Maton et al., 2016; Williams, 2014).

Findings on Women of Color's motivation and persistence plans to complete STEM undergraduate majors as pathways to Ph.D. studies and STEM research careers also go beyond the historical focus in college persistence studies on the role of academic and social integration in attrition and drop-out during the early undergraduate years; this study examined Women of Color's motivation and persistence plans during the more advanced undergraduate-to-graduate studies transition (e.g., Astin, 1984, 1993; Bean, 1982. 1985; Berger & Milem, 1999; Cabrera, Nora, & Castaneda, 1993; Pascarella & Terenzini, 1991, 2005; Tinto, 1975, 1993). Thus, my findings supporting the RSCCM propositions go beyond traditional college persistence studies to provide new insights into socio-cognitive motivational mechanisms that help to better explain why some Women of Color persist in undergraduate STEM majors as pathways to advanced Ph.D. studies and research careers. However, future research should better explain why different indicators of advanced STEM persistence plans — STEM major, Ph.D. studies, research career — were often predicted by specific socio-cognitive motivation variables — self-efficacy, outcome expectancies, perceived STEM talents, strong mentoring appraisals, perceived discrimination.

Second, my RSCCM finding also provide a foundation to fill a critical ***theoretical gap*** in evaluation studies documenting the efficacy of exemplary STEM pipeline interventions. The RSCCM identifies and clarifies the operation of key motivational mechanisms that help to explain the efficacy of STEM exemplary interventions, especially among underrepresented students. First, all Women of Color STEM majors in this study applied to the SROP interventions with strong academic backgrounds and *strong motivation* to pursue advanced Ph.D. studies and STEM research careers. Second, some were provided with strong SROP intervention activities including state-of-the-art scientific research opportunities with faculty mentors, appropriate facilities, and a multi-component social support system. Third, SROP intervention activities — especially social/verbal encouragement from faculty mentors — further strengthened their *motivation* to persist in STEM majors, to pursue advanced degrees, and to succeed in scientific research careers.

Third, building on insights from EVT and a related role strain model, my RSCCM findings provided a more in-depth analysis of socio-cognitive motivation predictors of STEM persistence plans among Women of Color (e.g., Bandura, 1982, 1986; Bowman, 1977, 2012; Eccles & Wigfield, 2002; Feather, 1982; Lawler, 1994). In addition to self-efficacy, RSCCM findings that various outcome expectancies, perceived STEM talents, and STEM intervention-based appraisals were also significant socio-cognitive motivation predictors of STEM persistence plans are especially consistent with EVT-driven research in educational, and organizational settings (Eccles & Wigfield, 2002; Hackett, 1997; Lawler, 1994).

Also building on principles from EVT, the RSCCM findings on the significant interactions between STEM self-efficacy and perceived racial/gender discrimination in motivating STEM persistence plans is consistent with role strain and adaptation studies (e.g., Bowman, 2006, 2012; Burt, Williams, & Smith, 2018). This finding suggest that STEM self-efficacy may be especially critical for STEM persistence when Women of Color face systemic barriers associated with both race and gender. Hence, STEM persistence among Women of Color may require strong STEM-related self-efficacy, strong outcome expectations, as well as socio-cognitive appraisals of systemic barriers that threaten their longer-term STEM career outcomes (Byars & Hackett, 1998; Byars-Winston et al., 2010; Byars-Winston & Foaud, 2008).

Limitations and Implications for Future Research

The RSCCM and related findings in this study have important implications for future research to further clarify the reformulated propositions in larger and more diverse samples. Because of the small sample size in the current study, perhaps the major implication for future research is to investigate all hypothesized relationships with larger samples of both Women of Color and other underrepresented students at various stages of career development. The analytical sample for this dissertation is 179 Women of color who applied to the SROP at 14 major universities affiliated with the BTAA. However, because of missing data, the analytic sample size varied across specific analyses and was relatively small for the final regressions, which included the largest number of predictors. Therefore, future research should utilize larger samples to further investigate both statistically significant findings as well as other RSCCM hypotheses that were not supported by findings in this exploratory study. In addition to larger samples, RSCCM findings in this study that undergird the importance of socio-cognitive motivation in persistence plans among Women of Color can also inform future research on other underrepresented group that are underrepresented in STEM.

Future studies should also address a range of questions raised by the RSCCM and related study findings on the *Multidimensional STEM Self-Efficacy Scale*, *various STEM outcome expectancies, perceived STEM talents*, *STEM intervention-based and other learning experiences*, *perceptions of socio-cultural contextual barriers and supports, STEM persistence plans and longer-term outcomes*, and the explanatory *role of socio-cognitive motivation factors*.

Multidimensional STEM Self-Efficacy – Overall Scale and Three Subscales

The Multidimensional STEM Self-efficacy Scale employed in the present study consisted of 18 items with an alpha coefficient revealing a high level of internal consistency (.90). A related factor analysis of the 18 items in the overall scale also revealed three-useful sub-scales: STEM Academic Self-efficacy, STEM Research Self-efficacy, and STEM Career Self-efficacy (see Appendix A). Each of these three subscales reflects a conceptual dimension of STEM self-efficacy, which is particularly relevant to students during the undergraduate-to-graduate student transition. Together, the Multidimensional STEM Self-efficacy Scale items tap three interrelated courses of action — academic, research, and professional career — which are critical for success in STEM research careers. Therefore, the overall Multidimensional STEM Self-efficacy Scale is especially relevant for the SROP applicant sample of academically high-achieving STEM undergraduate majors seeking research skills to prepare for advanced Ph.D. studies and faculty research careers.

The overall Multidimensional STEM Self-efficacy Scale is also more useful for the present study than traditional STEM self-efficacy measures because the sample of SROP Women of Color applicants represented a range of STEM majors, rather than a specific STEM field — math, science, engineering, etc. The majority of studies that have been conducted on STEM self-efficacy, persistence, and academic success have largely focused on specific academic areas, such as mathematics, science, or engineering (Gore et al., 2005) In contrast, the Multidimensional STEM Self-efficacy Scale taps a student's perceived abilities to be successful with academic, research, and scholarly career tasks relevant to a wide range of STEM majors, graduate studies, and career fields. Moreover, Multidimensional STEM self-efficacy or the ability to successfully execute actions in all three of these important areas may be necessary for SROP, and similar SROP-type programs, students' successful STEM research career development.

Future research should better clarify the explanatory power of both the overall Multidimensional STEM Self-efficacy Scale as well as the three STEM Self-efficacy subscales — academic, research, and career. Despite the utility of the overall Multidimensional STEM Self-efficacy Scale in the present study, future research should also employ the three specific STEM Self-Efficacy subscales, which may help to better explain specific STEM persistence plans and outcomes. Does STEM Academic Self-Efficacy have a stronger relationship to STEM major persistence plans and outcomes than either STEM Research or Career Self-Efficacy? Does STEM Research Self-Efficacy have a stronger relationship to Ph.D. plans and outcomes than either STEM Academic or Career Self-Efficacy? Does STEM Career Self-Efficacy have a stronger relationship to STEM research career plans and outcomes than either STEM Academic or Research Self-Efficacy?

Various STEM Outcome Expectancies and Perceived STEM Talents

Outcome expectations have been operationalized and examined in career research, particularly in the domain of STEM fields (Fouad, 2006). However, the construct of outcome expectations has not received as much attention in the career literature as has self-efficacy, requiring more research to fully understand the role of outcome expectations in career choice, development and persistence (Fouad, 2006). As such, findings in this study showed that self-efficacy is not the sole determinant of educational outcomes within the extension of the SCCT framework; various outcome expectancies also had significant relationships to STEM persistence plans for Women of Color. Specifically, while STEM self-efficacy did have a significant relationship to the STEM persistence plans among Women of Color, this study found that Women of Color were more strongly motivated by two path-goal outcome expectancies — intrinsic goal and societal-goal expectancies — having positive significant relationships to STEM persistence plans.

Future survey studies with larger samples as well as qualitative studies should better clarify the explanatory power of various kinds of outcome expectations (i.e., global, intrinsic, organizational, community uplift values) on Women of Color's STEM persistence plans and longer-term outcomes. It is especially critical that future longitudinal research further clarify how significant path-goal outcome expectancies — intrinsic and community uplift — help to explain both short-term STEM persistence plans and longer term outcomes (Elmore & Oyserman, 2012). Although organizational-goal outcome expectancies were not significant predictors in the present study, future qualitative and quantitative studies should further explore the role of these and other kinds of outcome expectancies on STEM persistence among Women of Color (Perez, Cromley, Kaplan, 2014). Future studies can also better explain the rather complex relationship found between intrinsic-goal outcome expectancies and perceived STEM talents among Women of Color. In addition to perceived STEM talents, future studies should also better explain the role of Artistic, Social and other types of perceived natural talents on STEM persistence and outcomes among Women of Color.

STEM Intervention-Based and Other Learning Experiences

The literature asserts that Bandura's (1986) four sources of self-efficacy information are defined by an order of power. That is, mastery experiences are the most powerful influencers, followed by vicarious learning experiences, verbal persuasion or encouragement from other and physiological or emotional arousal. In contrast, my study suggests that this is not the case when assessing STEM self-efficacy among the high-achieving Women of Color STEM undergraduate SROP applicants. My findings suggest that verbal encouragement from faculty research mentors is the significant source of STEM self-efficacy, rather than the empirically hypothesized ordered source of mastery experiences followed by vicarious learning experiences. Therefore, when examining the underrepresentation of Women of Color in STEM spaces, further research should apply more significant attention to the social and verbal encouragement from STEM faculty as a precursor to experiences en route to developing self-efficacy. This source that impacted socio-cognitive motivation among Women of Color on STEM persistence plans in this current study may be a better predictor for success than traditional self-efficacy predictors (e.g., GPA, exam scores). Future research should also seek other learning experiential sources of self-efficacy to explore alternate interpretations to understand what happens during the development of self-efficacy beliefs among Women of Color in STEM in the undergraduate-to-graduate studies transition.

Traditional social cognitive research on self-efficacy mostly seeks to identify factors that raise students' self-efficacy, often overlooking those that lower students' beliefs about their capabilities (e.g., Bandura, 1977; 1986; 1997). However, few of these traditional social cognitive studies employed approaches that take into account students' complex lives with diverse experiences and exposures, making information from the traditional sources of self-efficacy perhaps less relevant for different populations of students. Examining other sources of self-efficacy (e.g., one's cultural values, predispositions, access to resources) could help explain other cognitive process that account for self-efficacy development (e.g., Byars-Winston, et al., 2010).

Perceptions of the Socio-Cultural Context: Barriers and Support

Despite the primary focus on self-efficacy beliefs, a few SCCT researchers have also emphasized the importance of better understanding how socio-cognitive factors operate with broader *contextual factors* including supports and barriers to determine career development outcomes (Byars & Hackett, 1998; Byars-Winston, et al., 2010, Byars-Winston & Foaud, 2008). The SCCT model posits that perceived and objective barriers can interfere with the pursuits of a particular career path despite strong self-efficacy and outcome expectations (Brown & Lent, 1996). Given that the perception of barriers and supports may influence the pursuit toward a particular career, socio-cultural contexts represents a key variable to examine, especially when considering individuals from underrepresented backgrounds that may experience unique role-strain barriers and adaptive role supports that form their career outcomes.

Findings regarding the RSCCM socio-cultural contextual hypotheses, although mixed, suggest useful directions for further study of the relationships of socio-cultural contextual variables on STEM persistence plans outcomes. Future research should focus on the diverse educational levels, social circumstances, economic strata, and cultural backgrounds of students. (Lent, Brown, Chopra, Davis, Talleyrand, & Suthakaran, 2001). Furthermore, Byars & Hackett (1998) provide a SCCT conceptual extension showing how socio-cognitive factors may mediate the impact of race/gender status, background affordances, and proximal socio-cultural contextual factors on career-related outcomes among Women of Color. In subsequent SCCT reviews, Byars-Winston and colleagues also show how intervening in the academic and career behavior of Women of Color necessitate a deeper understanding of socio-cognitive processes by which contextual and cultural variables exert their influence on career-related outcomes (Byars-Winston, et al., 2010; Byars-Winston & Foaud, 2008). These critical reviews provide empirical support to replicate studies using the reformulation of SCCT to better understand motivational and socio-cultural contextual mechanisms that promote STEM persistence among Women of Color in strengths-based interventions.

STEM Persistence Plans and Longer-Term Persistence Outcomes

For a more meaningful analysis of STEM persistence, research on Women of Color should focus on both short-term persistence plans and longer-term STEM persistence outcomes. As an EVT, the Theory of Planned Behavior and related empirical evidence support the importance of short-term STEM persistence plans or intentions in predicting longer-term STEM persistence behaviors and outcomes (e.g. Fishbein & Ajzen, 1975; Ajzen, 1988). This is especially important when examining Women of Color transitioning from STEM undergraduate programs to STEM graduate studies, as this time period represents a significant drop in STEM retention (Ong et al., 2011). Future research should consider longitudinal studies to track actual persistence outcomes of study participants, particularly to understand long-term impacts of key socio-cognitive motivation on STEM persistence.

Role of Socio-Cognitive Motivation Factors: Beyond Prediction

Guided by the RSCCM conceptual framework, multiple regression analysis was used to investigate the hypothesized relationships between various socio-cognitive motivation predictors and STEM persistence plans. Future research should consider Structural Equation Modeling (SEM) for estimating the complex direct and indirect relationships depicted in the overall conceptual framework of the RSCCM. The specific measures and theory-driven findings in this present study that focused on motivation predictors should provide a better foundation for future studies to employ SEM to further validate related measurement and structural models in the broader RSCCM.

Future research should also consider the institutional context of the Big Ten Academic Alliance – Summer Research Opportunity Program (BTAA-SROP) since the BTAA-SROP occurs at 14 different research institutions. Some institutions may have different impacts on student's experience that may influence STEM persistence plans. A hierarchical linear model analysis may provide insight into the effect institutions may have on STEM persistence plans among Women of Color. Relatedly, to investigate the mediating STEM intervention efficacy, researchers should consider randomized experiments to test the subsequent differences on STEM persistence plans caused, on average, by the intervention.

Practical Implications: STEM Pipeline Intervention Policy and Programs

The RSCCM and related study findings have important implications for theory, research and practice. First, RSCCM findings have theoretical significance for better understanding the multiple sources of motivation in STEM persistence decisions among Women of Color, especially during advanced stages of career development. Second, findings have important implications for future research to further clarify RSCCM propositions on larger and more diverse samples. Finally, RSCCM findings have policy relevance for informing strengths-based strategies that promote STEM persistence among Women of Color by reinforcing the multiple socio-cognitive motivational strengths that they bring to the BTAA-SROP and other pipeline intervention settings.

At a theoretical level, this dissertation provides supportive evidence for a RSCCM that goes beyond existing formative and outcome evaluation studies on strengths-based interventions by better explaining the role of self-efficacy as well as other pivotal motivational strengths that empower some Women of Color to benefit from intervention activities more than others. In additional to the theoretical significance, the present study findings also highlight the ***policy and practical implications*** of strengths-based pipeline interventions that provide both strong faculty mentoring and more comprehensive support systems to leverage the unique socio-cognitive motivational strengths that Women of Color often bring to intervention settings. The RSCCM acknowledges the empirical evidence from summative interventions in promoting STEM persistence and related career success (e.g. Maton & Hrabowski, 2004; Hrabowski et al., 2002). Related formative evaluations have also shown that these strengths-based interventions are characterized by multiple components including strengths-based recruitment, comprehensive support systems and institutional commitment. As depicted in Figure 6.1, the RSCCM, a central tenet is that the intervention-based experience faculty mentor encouragement provides a strong intervention-based source of self-efficacy. Also, in this study, socio-emotional wellbeing provides a strong source of outcome expectations, which, in turn, increases socio-cognitive motivation and successful STEM outcomes.

In terms of policy implications, the focus on exemplary SROP interventions highlights the role of exemplary strengths-based interventions in supporting this nation's global competitiveness by promoting the motivation and persistence of Women of Color to complete STEM undergraduate majors as pathways to both advanced Ph.D. studies and research careers. In addition to SROP interventions, findings on the role of strengths-based interventions to reinforce STEM motivation and persistence among Women of Color also have important policy implications for other pipeline interventions sponsored by the NIH, NSF, Department of Education, foundations and other stakeholders.

With a focus on SROP at major research universities, findings from this study contribute to NIH-NIGMS initiative to identify and clarify key motivational mechanisms that help explain the efficacy of exemplary STEM interventions. Consistent with three strengths-based motivational assumptions, SROP-applicant undergraduate participants: (1) were recruited with *both* strong academic backgrounds and strong motivation to pursue advanced Ph.D. studies and faculty research careers; (2) {those applicants that participated in the BTAA-SROP or similar undergraduate research experiences} were provided with *strong* intervention-based activities including state-of-the art scientific research opportunities with faculty mentors, appropriate facilities, and a multi-component support system; and (3) demonstrated multiple STEM motivational strengths that promoted their commitment to persist in STEM majors, to pursue advanced degrees, and to succeed in scientific research careers.

At the program level, specific findings on the role of multiple socio-cognitive motivation predictors in STEM persistence plans among Women of Color also have some implications for program practitioners. As summarized in Figure 6.1, major findings further clarify a range of socio-cognitive motivational strengths that program practitioners within pipeline interventions should find ways to reinforce to better promote STEM motivation and persistence among Women of Color. Based on these major findings, SROP and other pipeline program practitioners should consider the following specific recommendations to promote STEM motivation and persistence of Women of Color at various stages of career development:

MULTIDIMENSIONAL STEM SELF-EFFICACY: Practitioners should develop specific programmatic strategies to better promote each participant's beliefs in their capabilities to organize and execute the STEM *academic, research*, and *professional career* courses of actions necessary for success in advanced Ph.D. studies and research careers.

STEM INTRINSIC AND UPLIFT PATH-GOAL MOTIVATION: Practitioners should develop specific programmatic strategies to better promote each participant's beliefs that STEM research careers are viable pathways for achieving both their *intrinsic goals* for self-fulfillment as well as their highly valued goals for *community uplift.*

PERCEIVED STEM NATURAL TALENTS: Practitioners should develop specific programmatic strategies to better reinforce and develop the *self-perceptions a*mong many Women of Color that they bring *natural STEM talents* to intervention settings.

INTERVENTION-BASED MENTOR ENCOURAGEMENT: Practitioners should develop mentor training and other programmatic strategies to ensure that faculty mentors provide participants with social/verbal encouragement to persist in STEM majors as pathways to advanced Ph.D. studies and research careers.

PREVIOUS SOCIAL-EMOTIONAL LEARNING: Practitioners should be prepared to provide the necessary support for participants whose STEM motivation and persistence might be threatened by stress, distress, or depressive affect from previous socio-emotional learning.

OTHER PERSISTENCE PREDICTORS: In addition to socio-cognitive motivational strengths, practitioners should also seek to better understand why pipeline intervention strategies may promote STEM persistence plans better for participants who major in the biomedical/behavioral sciences than in other STEM fields.

ROLE OF RACIAL/GENDER DISCRIMINATION: Practitioners should develop specific programmatic strategies to reinforce STEM self-efficacy among participants who experience racial and gender discrimination.

If the U.S. is to continue to lead the global economy in scientific and technological advances, STEM pipeline intervention programming must expand and transform STEM academic pathways that serve the full spectrum of the increasingly diverse student population (St. John & Musoba, 2010). Understanding the complexity of Women of Color's socio-cognitive motivation is critical to creating successful initiatives that reinforce motivation toward undergraduate STEM degree completion, graduate studies, advanced STEM careers. Findings in this study create a strong foundation for further research on socio-cognitive motivation and STEM persistence among Women of Color and other underrepresented groups in STEM. Initial results should also aid institutional practices and policies, as well as other stakeholders' understanding of the importance of motivation as it related to STEM persistence among Women of Color.

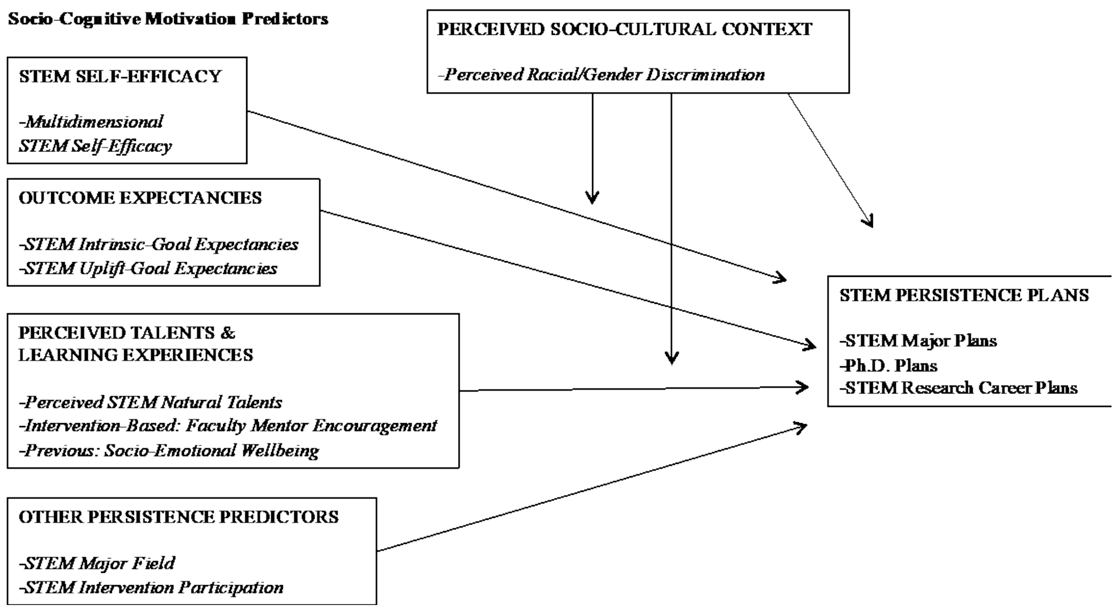


Figure 6.1: Findings - Socio-Cognitive Motivation Predictors and STEM Persistence Plans

Appendix A

Multidimensional STEM Self-efficacy Scale

Variable Description and Operational Definition

The Multidimensional STEM (MSTEM) Self-efficacy Scale consists of 18-items that tap a student's belief that they are capable of executing the necessary *academic, research* and *career-relevant* action necessary for a successful research career in Science, Technology, Engineering, or Mathematics (STEM). More specifically, the MSTEM Self-Efficacy Scale consist of items to tap a person's belief about their ability to execute these *three core dimensions* of STEM research career competence — *STEM Academic self-efficacy* (7 items), *STEM Research self-efficacy* (6 items), and *STEM Career self-efficacy* (5 items). The 18-item scale requests students to respond to the following prompt: "Compared with other college students, rate yourself in the following career-related areas" using a 5 point scale, where 1 = lower 10% and 5 = upper 10% for the 18 items. Students' ratings on the 18 MSS items reflect their self-efficacy beliefs about their STEM academic, research, and career-relevant abilities or skills. The overall MSTEM Self-Efficacy Scale score assess a student's self-efficacy across all three core dimensions of STEM research career competence, while the three subscales may tap more specific *academic*, *research* and *career-relevant* dimensions of STEM Self-efficacy.

Conceptual Definition and Background

In general, self- efficacy is conceptually defined as one's beliefs in their "capabilities to organize and execute the courses of action required to produce given attainments", (Bandura, 1997, p. 3). Consistent with this definition, the 18 item MSS Scale taps a person's beliefs that they are capable of executing the necessary *academic, research* and *career-relevant* action necessary for a successful STEM research career. The MSS focus on a student's belief about their ability to execute these three core dimensions of STEM research career competence goes beyond traditional measures of STEM Self-efficacy. ***Traditional*** STEM self-efficacy scales for students have most often focused on the concept of *Math self-efficacy* to tap one's belief about their *academic* capabilities or skills in mathematics (e.g., Bretz & Hackett, 1993;). In addition, there is also a growing focus on *Science Self-efficacy* to assess a student's belief about their specific *career* capabilities in scientific fields (e.g. Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). However, the MSS Scale may be more relevant for studies on advanced undergraduate STEM majors in *multiple* STEM fields than such traditional measures that focus on *either* math, science, engineering, etc. MSTEM self-efficacy may be a significant source of motivation and persistence for students during the undergraduate-to-graduate studies transition and other advanced stages of STEM career development (e.g. Bandura, 1976, 1977b). For example, as a socio-cognitive motivation construct, MSTEM Self-efficacy may have predictive utility in helping to explain which STEM undergraduate students complete the STEM majors, pursue advanced Ph.D. studies, and succeed in STEM research careers.

Scale Development and Preliminary Psychometric Analyses

The MSTEM Self-efficacy Scale was developed based on data collected from a sample of Women of Color advanced undergraduate students — college juniors and seniors - who applied to a competitive summer research program with both strong academic preparation and an expressed interest in pursuing advanced doctoral studies. Preliminary psychometric analyses of the MSTEM Self-efficacy Scale support the utility and meaningfulness of the overall 18-item scale as well as the subscales that focus on the three core dimensions. The Cronbach alpha coefficients are substantial for both the overall MSTEM Self-efficacy Scale (.90) and the three subscales — *STEM Academic self-efficacy* (.77), *STEM Research self-efficacy* (.91), and *STEM Career self-efficacy* (.74). In addition to these alpha coefficients, the meaningfulness and utility of the three MSTEM Self-efficacy subscales are further supported by ***factor analysis***. An exploratory factor analysis with an orthogonal rotation and applying maximum likelihood estimation resulted in the initial extraction of 4 factors that accounted for 51.7% of the variance in the 18 items. However, a visual examination of the factor analysis scree plot revealed that 3 factors would be sufficient, thus a second exploratory ML factor analysis was conducted forcing the extraction of 3 factors. As summarized in Table A-1, the 3 factors extracted in this second factor analysis accounted for 46.4% of the variance in the items comprising the MSTEM Self-efficacy scale. These factor analytic results (pattern from the ML orthogonal rotation) provide additional support for the meaningfulness of the subscales for taping three core dimensions of STEM self-efficacy.

Factor Analysis of the Multidimensional STEM Self-Efficacy Scale Items

STEM Self-efficacy items (Perceived Ability/Skills)	STEM Research Self-efficacy	STEM Academic Self-efficacy	STEM Career Self-efficacy
Data collection skills	**.77**	.20	.26
Data analysis skills	**.74**	.26	.25
Question development skills	**.71**	.31	.24
Report writing skills	**.68**	.33	.25
Literature review skills	**.68**	.32	.22
Research presentation skills	**.56**	.33	.24
Reading skills	.25	**.60**	.14
Essay writing skills	.29	**.57**	.12
Intellectual ability	.30	**.55**	.24
Material comprehension skills	.27	**.49**	.17
Note taking skills	.12	**.36**	.07
Leadership skills	.22	**.36**	.22
Time management skills	.23	**.34**	**.31**
Research career ability	.10	.04	**.32**
Ph.D. ability	.41	.20	**.79**
Problem solving skills	.29	.29	**.74**
Natural science comprehension skills	.23	.25	**.47**
Quantitative skills	.07	.11	**.27**
VAF (rotated)	20.1	14.2	12.2

Appendix B

Survey Items for each Construct with Scale Variables and Reliabilities

Construct, Survey Questions, Scale / Response options
STEM Persistence Plans
What are your future plans – how certain are you about the following? 5-point Likert-type scale ranging from "completely certain I will" to completely certain I will not" STEM Major Plans Pursue an undergraduate major or minor in Science, Technology, Engineering, or Mathematics? Ph.D. Plans Pursue a Ph.D. degree? STEM Research Career Plans Pursue a research career in some Science, Technology, Engineering, or Mathematics field?
Multidimensional STEM Self-Efficacy
STEM Academic Self-Efficacy, (alpha = .66), 5-point Likert-type scale ranging from "Lower 10%" to Upper 10%"

Compared with other college students, rate yourself in the following Academic Areas: Math and quantitative computations (true/false, multiple choice, etc.). Comprehension of material in natural sciences. Your intellectual potential. STEM Research Self-Efficacy, (alpha = .91), 5-point Likert-type scale ranging from “Lower 10%” to Upper 10%” Compared with other college students, rate yourself in the following Research Areas: Your ability to give a presentation based on your own research. Your ability to develop a research statement and questions. Your ability to conduct a research literature review. Your ability to collect data for a research project. Your ability to analyze data for a research project. Your ability to write a formal research report. STEM Career Self-Efficacy, (alpha = .79), 5-point Likert-type scale ranging from “Lower 10%” to Upper 10%” Compared with other college students, rate yourself in the following Career-Related Areas: Your preparation to pursue Ph.D. studies. Your preparation to pursue a research career. Your ability to solve various life problems that could interfere with your educational or career progress. Your ability to assume leadership roles in group, community service, or organizational activities.
Outcome Expectancies
Global Outcome Expectancies (alpha = .81), 4-point scale ranging from “completely false” to “completely true”).

Rate the degree to which the following statements are TRUE FOR YOU (personally): I've always felt that I could make my life pretty much what I wanted to make out of it. Once I make my mind up to do something, I stay with it until the job is completely done. I like doing things that other people thought could not be done. When things don't go the way I want them to, that just makes me work even harder. Sometimes I feel that if anything is going to be done right, I have to do it myself. It's not always easy, but I manage to find a way to do the things I really need to get done. Very seldom have I been disappointed by the results of my hard work. I feel that I am the kind of individual who stands up for what he/she believes in, regardless of the consequences. In the past, even when things got really tough, I never lost sight of my goals. It's important for me to be able to do things the way I want to do them rather than the way other people want me to do them. I don't let my personal feelings get in the way of doing a job. Hard work has really helped me to get ahead in life.
<u>Path-Goal Outcome Expectancies</u>
Intrinsic Goal-Expectancy, (alpha = .84), 5-point Likert-type scale ranging from “absolutely necessary” to “absolutely unnecessary How much can successful preparation for a PhD degree and research career help you in achieving each outcome: Self confidence and feelings of accomplishment? A chance to develop personal ideas and values? Achieving greater awareness of yourself and the world? Organizational Goal-Expectancy, (alpha = .74), 5-point Likert-type scale ranging from “absolutely necessary” to “absolutely unnecessary How much can successful preparation for a PhD degree and research career help you in achieving each outcome: Admiration and respect of fellow students? Praise and recognition from your teachers?

Credits towards a college degree? Achieving skills and knowledge for your chosen career? Societal Goal-Expectancies Which of the following career areas do you feel best enable each student: Biomedical/behavioral sciences; Other basic or applied sciences; social sciences; creative arts; Other — Yes; No (Ann/Art) decided to attend college so that s(he), as an individual, can really “make it” economically. Most important is to acquire material luxuries and personal wealth. (S)he wants to really advance her / himself and be highly respected by other affluent people. (Betty/Bob) is tired of seeing low communities get a bad deal. S(he) decided that college offered her/him an opportunity to acquire skills to help improved the plight of low-income people. (S)he really wants to do something more meaningful for people who are less fortunate. (Cathy/Carl) is really not as economically ambitious as Ann/Art, nor as committed to social causes as Betty/Bob. (S)he feels that a college degree would allow her/him to pursue a career that (s)he loved. (S)he wants a college career to develop and fully utilize her/his personal talents.
Prior Learning and Intervention-based Experiences
STEM Academic Mastery What was your GPA last term? Open Response Vicarious Intervention Peer Learning, (alpha = .90), 5-point Likert-type scale ranging from “definitely yes” to “definitely no” Would other students affiliated with your research experience help you out in the specific ways listed below? Other students affiliated with my research experience last summer would: Tell me about available choices and options. Show me how to do something I didn’t know how to do. Tell me what to do.

Help me decide what to do. STEM Mentor Verbal and Social Persuasion, (alpha = .92), 4-point Likert-type scale that ranged from “strongly agree” to “strongly disagree”. Please indicate the degree to which you agree or disagree with the following statement about your faculty mentor? My mentor provides support and encouragement. My mentor serves as a sounding board for me to develop and understand myself. My mentor thinks highly of me. My mentor would use his/her influence to support my advancement. My mentor gave me tasks that required me to learn new skills. My mentor brings my accomplishments to the attention of important people. My mentor helps guide my professional development. My mentor sees me as being competent. Affective State, (alpha = .80), 4-point Likert-type scale: options were: 1= Rarely or none of the time (< 1day); 2=Some or little of the time (1-2 days); 3=Occasionally or a moderate amount of the time (3-4 days); 4=Most or all the time (5-7) days. I felt depressed. I could not get “going”. I felt hopeful about the future. I thought my life had been a failure. I felt sad.
Social-Cultural Context
Socio-Cultural Contextual Barriers
Perceived Discrimination, Yes; No

Have you ever experienced any form of discrimination, harassment, or discomfort at (institution) because of your gender, race or, cultural background? Low Income (Pell Grant Eligibility), select most applicable option. When you entered college, did your received a PELL GRANT, and/or COLLEGE WORK STUDY? I was awarded a Pell Grant. I was awarded college work study. I was awarded both a Pell Grant & college work study. I was not awarded either.
<u>*Socio-Cultural Contextual Supports*</u>
Race Socialization, (alpha = .88), 3-point scale: “Do not remember/Never”; “Once/Sometimes”; “Always”. Did your PARENTS or the PEOPLE WHO RAISED YOU, ever teach you that: Despite life obstacles, you must believe in yourself If you are determined enough, you can break down major life barriers to success God should always be first in your life God and religion would help you cope with major life problems A college education was absolutely necessary in life A college education would help you cope with major life problems A close family not only means to love each other but also to share what you have A close family ties would help you cope with major life problems Good work habits would help you cope with major life problems Good work habits were important to develop early in life Involvement in ethnic organizations would help you cope with major life problems Working with diverse groups would be helpful in coping with major life problems Not only females, but males should help with housework Both males and females should equally strive for college degrees and careers

Racial/Ethnic Majority Campus, select most applicable option. 5-point scale: 1 = “All/Almost all persons of my ethnic group”, 2 = “Mostly persons of my ethnic group”, 3 = “About half of my ethnic group”, 4 = “Mostly persons of other ethnic groups”, 5 = “All/Almost all persons of other ethnic groups”
Perceived Natural STEM Talent
Do you have some specialized talent that you really enjoy, (for example, artistic, mathematical, athletic, creative writing, or other natural abilities)? Yes; No What is / are your specialized talent(s)? Open Response; first response indicated.
Background Characteristics
Gender Your sex is: Male; Female Race Are you of Hispanic, Latino, or Spanish origin? Yes; No With which racial /ethnic/cultural background do you primarily identify? African American, Black, Negro; American Indian or Alaskan Native; Asian American; Native Hawaiian/Other Pacific Islander; White, Caucasian; Other STEM Major If you have chosen a college major, which of the following fields is most related to your choice? Biomedical/behavioral sciences; other basic of applied sciences (e.g., physics, engineering); social sciences/related professions (e.g.,

sociology, law, business); creative arts/related professions (e.g., theater, art, dance, film); I have not yet chosen a college major

Age

Your year of birth is:

Year in College
Based on your total credit hours, what year are you in college?
Freshman, Sophomore, Junior, Senior

Mother's Educational Background
Please indicated the highest numbers of YEARS OF SCHOOL COMPLETED by each of the following family members

1-8 years
9-11 years
High school graduate
Some college
Four year degree (e.g., BA, BS)
Masters degree (e.g., MA, MS)
Doctoral degree (e.g., PhD, MD)
Not sure

Summer Research Experience Summer 2011

Summer Research Opportunity Program Participant
Non-Summer Research Opportunity Program Participant with a Summer Research Experience
Non-Summer Research Opportunity Program Participant without a Summer Research Experience

Appendix C

Measure Coding and Description

Measure	Description
STEM Persistence Plans	Students' degree of certainty they would purse an undergraduate major in STEM, pursue a Ph.D. degree, and pursue a research career in STEM.
Multi-Dimensional STEM Self-Efficacy	
STEM Academic Self-Efficacy	The degree to which students believe they possess the ability to master STEM-related academic tasks (Chemers, Hu, & Garcia, 2001).
STEM Research Self-Efficacy	The degree to which students believe they possess the ability to complete various STEM-related research tasks (Bieschke, Bishop, & Garcia, 1996).
STEM Career Self-Efficacy	The degree to which students believe they posses the ability to successfully engage in STEM-related career tasks (Taylor & Betz, 1983; Gushue, Scanlan, Pantzer, Clarke, 2006).
Outcome Expectancies	
Global Outcome Expectancies	Students' "self-perception that *she* can meet the demand of *her* environment through hard work and determination". (James, Hartnett, & Kalsbeek, 1983, p. 263) (John Henryism)
Path-Goal Outcome Expectancies	
Intrinsic Goal-Expectancies	Degree to which student perceived a Ph.D. and Research Career would help them to reach intrinsic goals.
Organizational Goal-Expectancies	Degree to which student perceived felt a Ph.D. and Research Career would help them to reach extrinsic goals.
Societal Goal-	Students' belief that the attainment of certain career would result in a

Expectancies❖	greater personal economic placement.
Prior Learning and Intervention-based Experiences	
STEM Mentors Verbal / Social Persuasion	Students' assessment of their research faculty mentor's support and affirmation of readiness for continued and advanced studies in STEM.
Vicarious Peer Learning	Students' assessment of the level of informal support from successful peers within the context.
STEM Academic Mastery	Students' self-reported GPA from previous term at Time 1
Student Emotional / Affective State	Students' level of depressive affect and symptoms, emotional arousal/ physiological and affective states. Depressive affect (CES-D) Radloff, L.S. (1997)
Socio-Cultural Context	
Socio-Cultural Contextual Barriers	(Subjective) Students' self-perceived experiences of discrimination, harassment, or discomfort at (their institution) because of gender, race or, cultural background? 1: Yes; 0:No (Objective) Students' eligibility for Pell and/or college work study. 1: Eligible; 0: Not Eligible
Socio-Cultural Contextual Support	(Subjective) Racial Socialization (Bowman & Howard, 1985). Students' perceived family support toward blocked opportunities. (Objective) Racial composition of students' home campus 1: All/Almost all to about half of participants' ethnic group; 0: Mostly to all/almost all person of other ethnic groups
Perceived Natural STEM Talent❖	Students' self-perceived specialized talents that they really enjoy (i.e., artistic, mathematical, athletic, creative writing, or other natural

	abilities) 1:STEM-related talents (e.g., Math, Science, Computer Science/Coding) 0: Arts and Humanistic talents; Athletic and Physical talents; Social and Empathy talents; Conscientiousness and Intellectual talents
Special Talent	1: STEM Talent 2: Artistic Talent 3: Athletic Talent 4:Service Talent 5:Intellectual Talent
Background Characteristics	
Female	1: Male 2: Female
Woman of Color❖	1: African American, Black 6: Hispanic, Latino
STEM Major❖	Students' college major 1: Biomedical/behavioral sciences; Other Basic or Applied Sciences (e.g., Physics, Engineering); Social Sciences (e.g., Psychology, Economics); 0: Creative arts/related professions (e.g., theater, art, dance, film); I have not yet chosen a college major
Type of STEM Major❖	Type of STEM college major 1: Biomedical/Behavioral Sciences and Social Sciences; 0: Other Basic or Applied Sciences
Summer Research Experience❖	Student applicant participation status in a summer research experience Summer 2011 1: Yes, participated in a summer undergraduate research experience (SROP or other SROP-like); 0: No, did not participate in a summer undergraduate research experience
Grades❖	Students' cumulative Grade Point Average (GPA) 1: "GPA = 4.0"; 2: "GPA = 3.9-3.0; 3: "GPA = 2.9-2.0"; 4: "GPA less than 2.0"
Student Year ❖	Participant Year in College 1: Freshman; 2: Sophomore; 3: Junior;

	4: Senior;
Age	Participant Age 1: 19 years of age or younger; 2: 20-23 years of age; 3: 24 years of age or older
Mother's Educational Background❖	Level of Education Attained by Participants' Mother 0: Less than a four year degree; 1: Four year degree; 2: Master degree or higher

❖Recodes of the original variables in the dataset

New construct developed with psychometric techniques

Appendix D

Table 6.1. Demographic characteristic comparisons between the Women of Color study sample and other relevant sub-samples

	Women[a]		Men[a]			
Variable	Women of Color (%)	Other Women (%)	Men of Color (%)	Other Men (%)	Total (%)	Chi Square *p*-value
I. Education Status						
Undergraduate STEM Major						$p = .001$***
Biomedical/Behavioral Sciences	76 (42%)	52 (38%)	34 (39%)	12 (18%)	174 (37%)	
Other Basic or Applied Sciences (e.g., Physics, Engineering)	32 (18%)	38 (28%)	31 (35%)	43 (62%)	144 (30%)	
Social Science (e.g., Psychology, Economics)	71 (40%)	46 (34%)	23 (26%)	14 (20%)	154 (33%)	
Total	179 (100%)	136 (100%)	88 (100%)	69 (100%)	472 (100%)	
Summer Research Experience						$p < .001$***
BTAA-SROP	96 (66%)	47 (41%)	51 (76%)	36 (58%)	230 (59%)	
BTAA-SROP-like	20 (14%)	35 (30%)	11 (16%)	11 (18%)	77 (20%)	
No Summer Research Experience	29 (20%)	34 (29%)	5 (8%)	15 (24%)	83 (21%)	
Total	145 (100%)	116 (100%)	67 (100%)	62 (100%)	390 (100%)	
Grades (Cum. GPA)						n.s.
A (GPA=4.0)	24 (20%)	28 (26%)	7 (12%)	15 (25%)	74 (21%)	
B (GPA=3.9 - 3.0)	95 (77%)	73 (69%)	46 (81%)	38 (65%)	252 (73%)	
C (GPA=2.9 - 2.3)	4 (3%)	5 (5%)	4 (7%)	6 (10%)	19 (6%)	
Total	123 (100%)	106 (100%)	57 (100%)	59 (100%)	345 (100%)	
Student Year						n.s.
Senior	88 (69%)	64 (59%)	46 (78%)	37 (62%)	235 (66%)	
Junior	33 (26%)	34 (32%)	8 (13%)	21 (35%)	96 (27%)	
Sophomore	6 (5%)	10 (9%)	4 (7%)	2 (3%)	22 (6%)	
Freshman	0 (0%)	0 (0%)	1 (2%)	0 (0%)	1 (.3%)	
Total	127 (100%)	108 (100%)	59 (100%)	60 (100%)	354 (100%)	
II. Socio-Demographic Background						
Age						n.s.
18-19 yrs.	11 (6%)	7 (5%)	6 (7%)	3 (4%)	27 (6%)	
20-23 yrs.	147 (83%)	111 (82%)	69 (78%)	53 (77%)	380 (81%)	
24 yrs. and over	20 (11%)	17 (13%)	13 (15%)	13 (19%)	63 (13%)	
Total	178 (100%)	135 (100%)	88 (100%)	69 (100%)	470 (100%)	
Low Income (Pell Grant Eligibility)						n.s.
Yes	77 (63%)	60 (58%)	35 (66%)	28 (47%)	200 (59%)	
No	46 (37%)	44 (42%)	18 (34%)	31 (53%)	139 (41%)	
Total	123 (100%)	104 (100%)	53 (100%)	59 (100%)	339 (100%)	
Mother's Educational Background						n.s.
Less than four year degree (e.g., BA, BS)	59 (49%)	55 (54%)	28 (57%)	26 (47%)	168 (52%)	
Four year degree (e.g., BA, BS)	32 (27%)	26 (25%)	15 (31%)	17 (30%)	90 (27%)	
Masters Degree (e.g., MA, MS) or higher (e.g., MD, PhD)	29 (24%)	21 (21%)	6 (12%)	13 (23%)	69 (21%)	
Total	120 (100%)	102 (100%)	49 (100%)	56 (100%)	327 (100%)	
Racial/Ethnic Majority Campus[b]						$p = .012$*
Mostly or all of my racial/ethnic group	71 (59%)	75 (74%)	24 (48%)	34 (61%)	204 (62%)	
Mostly of all of other racial/ethnic groups	50 (41%)	27 (26%)	26 (52%)	22 (39%)	125 (38%)	
Total	121 (100%)	102 (100%)	50 (100%)	56 (100%)	329 (100%)	

Notes. [a]Only STEM majors included in this analysis using the National Science Foundation (NSF) definition.
[b]Student's home campus.
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Appendix E

Table 6.1. ANOVA Comparisons of Women of Color and other sub-groups on socio-cognitive motivation factors

Predictor Variables	Women[a]				Men[a]				
	Women of Color (N=179)		Other Women (N=136)		Men of Color (N=88)		Other Men (N=69)		
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	*F* (Sig.)
Multidimensional STEM Self-Efficacy	3.95	.58	3.97	.54	4.13	.58	4.29	.54	7.47 ($p < .001$)***
Outcome Expectancy									
Global Outcome Expectancy	3.20	.35	3.12	.35	3.22	.41	3.19	.35	1.38 (.25)
Intrinsic-Goal Expectancy	4.38	.81	3.90	.99	4.30	.85	3.93	.92	5.14 (.002)**
Organizational-Goal Expectancy	4.02	.82	3.82	.83	4.01	1.00	3.97	.86	0.95 (.42)
Societal-Goal Expectancy	1.04	1.24	1.34	1.25	.92	1.17	1.23	1.31	2.56 (.05)
Intervention-based Experiences									
STEM Mentor Social and Verbal Persuasion	3.28	.52	3.18	.50	3.29	.70	3.40	.54	1.45 (.23)
Vicarious Intervention Peer Learning	4.36	.73	4.08	.80	4.15	.86	3.98	1.03	2.89 (.04)
STEM Academic Mastery (Cum. GPA)	3.61	.33	3.66	.37	3.51	.39	3.67	.41	2.55 (.06)
Student Emotional State (CESD Depression)	1.53	.64	1.72	.71	1.55	.57	1.67	.71	1.88 (.13)
Perceived STEM Talents	.04	—	.04	—	.02	—	.17	—	7.72 (p < .001)***
Perceived Socio-Cultural Context									
Perceived Discrimination (Racial/Gender)	1.70	—	1.63	—	1.74	—	1.76	—	0.89 (.45)
Low Income (Pell Grant Eligibility)	.63	—	.58	—	.66	—	.47	—	1.70 (.17)
Perceived Racial Socialization	2.54	.39	2.21	.41	2.49	.41	2.23	.42	11.97 ($p < .001$)***
Racial/Ethnic Majority Campus[b]	.59	—	.74	—	.48	—	.61	—	3.58 (.014*)
STEM Persistence Plans									
STEM Major Plans	3.09	1.91	3.43	1.77	4.13	1.65	4.30	1.52	6.57 ($p < .001$)***
Ph.D. Plans	4.14	1.02	4.09	1.01	4.04	1.16	4.32	.96	0.73 (.54)
STEM Research Career Plans	2.61	1.38	3.00	1.41	3.31	1.46	3.64	1.19	7.56 ($p < .001$)***

Notes. [a]Only STEM majors included in this analysis using the National Science Foundation (NSF) definition.
[b]Student's home campus.
*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

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