Financial Impediments, Academic Challenges and Pipeline Intervention Efficacy: A Role Strain and Adaptation Approach to Successful STEM Outcomes for Underrepresented Students

by

Krystal L. Williams

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Higher Education)
in the University of Michigan
2014

Doctoral Committee:

Professor Phillip J. Bowman, Chair
Associate Professor Deborah F. Carter
Associate Professor Robert J. Jagers
Professor Brian P. McCall
Professor Edward St. John

DEDICATION

Without counsel plans fail, but with many advisers they succeed

Proverbs 15:22

This work is dedicated to all of the friends, family and advisers who invested in my personal and academic development, knowingly and unbeknownst.

ACKNOWLEDGEMENTS

On the surface, the dissertation can appear to be the fruits of individual labor. The research provides a platform for a scholars' future development and an intense academic experience for his or her professional enhancement. In an ideal scenario, the topic area provides a glimpse into the writer's academic passions. With all its glitz and glory, there will be individual gains and losses, victories and setbacks.

While each of these perspectives merits consideration, I reference ***this*** work as a culmination of team efforts. Although this is my dissertation, it would not have been possible without support from a broader community. First, I would like to acknowledge my dissertation chair, Dr. Phillip Bowman, who has not only provided guidance during this research process, but has also served as a teacher, mentor, advisor, strategist and confidant. Thank you for all of your support with crafting and completing a study that not only makes intellectual contributions to Higher Education, but also aligns with my value system.

I would also like to acknowledge my other academic extended family. This includes my committee members, each of my colleagues from the University of Michigan National Center for Institutional Diversity Dissertation Support Group, writing buddies, coffee shop companions, and editors (volunteers and those commissioned). Each of you offered perspectives that helped me to craft a better study and defensible ideas. Similarly, I would like to thank the University of Michigan Center for the Education of Women for providing me with an opportunity to explore the global implications of this research. Because of your support, I was able to study the cross-cultural implications of this work and develop strategies for future expansion.

Last, but not least, I would like to acknowledge by family for all of its support, not only during this process, but also throughout my entire academic career. Your encouragement, diligence and commitment made all of this possible. I recognize your altruism and the individual sacrifices each of you has made to help me to achieve my personal goals. For that, I not only offer many thanks, but also acknowledge this work as a product of our joint efforts.

This study is supported by the National Institutes of Health - National Institute for General Medical Sciences (1R01Gm088750-01) and based at the University of Michigan National Center for Institutional Diversity.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

DEFINITION OF KEY TERMS

Ability Blame= The perception that student role difficulties are caused by one's own personal deficits (Bowman & Sanders, 1998 (Adaptation))

Academic Discouragement= The degree to which students felt discouraged by academic difficulties in the student role (Feldman, 1999 (Adaptation))

Academic Student Role Strain= The objective difficulties that students encounter due to a lack of academic preparation/exposure, and students' subjective appraisal of those difficulties which can potentially serve as impediments to college success

Advanced STEM Career Plans= Students' plans to pursue a STEM career that requires extensive academic training

Extended Family Support= Perceived support from family members including the nuclear family, intergenerational kin, and para-kin (Reyes, 2002)

Financial Discouragement= The degree to which students felt discouraged by financial difficulties

Financial Stress= The degree to which students experience stress due to financial challenges

Financial Student Role Strain= The objective and subjective challenges that students encounter due to financial hardships which can potentially serve as impediments to college success

John Henryism= Self-perception about an individual's ability to employ hard work and determination to meet environmental demands; Operational definition for personal resiliency

Personal Resiliency= A person's ability to bounce back from, and thrive in, the face of adversity (Bowman, 2013)

Student Role Strain= The objective difficulties that individuals face in their role as students, as well as the affiliated cognitive/subjective appraisal of those difficulties (Bowman, 2006)

ABSTRACT

A growing number of studies highlight how exemplary pipeline interventions can promote college and career success in science, technology, engineering, and mathematics (STEM). However, it is also important to understand how the challenges and strengths that underrepresented students bring to intervention settings can influence their successful STEM outcomes. Guided by role strain and adaptation theory, this study seeks to better explain how intervention participation combines with other pivotal factors to influence students' plans to pursue research careers in STEM fields. This theory-driven study makes unique contributions to the higher education pipeline intervention literature by further clarifying social psychological mechanisms through which financial and academic challenges impede successful STEM outcomes among underrepresented students within intervention settings. Analyses of longitudinal survey data from 376 underrepresented students who applied to an exemplary Summer Research Opportunity Program at 12 major research universities in the Midwest provided support for several hypotheses. Multivariate analyses found that STEM research career plans appear to be enhanced by intervention participation, but impeded by financial and academic challenges (both objective barriers and subjective threats). Study findings also suggest that personal resiliency, a measure of adaptive cultural strength, can also promote successful STEM outcomes. Study findings support the importance of students' role strains and strengths in better understanding STEM-related intervention outcomes for underrepresented students. The theory-driven findings can help program administrators and policy-makers better determine not only if, but how, higher education pipeline interventions promote successful STEM outcomes for underserved groups.

CHAPTER I

INTRODUCTION

There is a growing interest in better understanding the factors that influence the education pipeline from high school to higher education and competitive career fields for students from underrepresented groups (Greene & Forster, 2003; Greene & Winters, 2005; Perna, 2006). While the overall success rates for students in science, technology, engineering, and mathematics (STEM) fields are problematic, the success rates for various subgroups are even lower. For example, a report by the National Action Council for Minorities in Engineering (2008) indicates that, in 2006, 68,000 engineering bachelor's degrees were awarded in the United States and only 8,500 of those were awarded to underrepresented students of color. With regard to doctoral studies, the report also indicates that of the 6,404 doctoral degrees that were awarded that same year, a little over 200 were awarded to students in this group. Despite the low number of degrees awarded to minority students, other research indicates that there has been an increase in minority students' share of STEM bachelor's and master's degrees over the last few decades (National Science Foundation, 2013). While the share of doctoral degrees awarded to minorities has increased since the early 1990's, this percentage has plateaued at about 10% since 2000 (National Science Foundation, 2013).

There is also an issue regarding the gender gap in STEM fields. While there is a push to increase female representation in STEM fields overall, the gender disparity differs drastically by field. For example, while women have earned a high percentage of bachelor's degrees in psychology since the early 1990's, they have been particularly underrepresented in other STEM fields such as engineering, physics and computer science (Hill, Corbett & St. Rose, 2010; National Science Foundation, 2013)[1]. Gender disparities in STEM are also prevalent at the graduate level. While women's representation amongst doctoral degree recipients in STEM fields has improved over the last several decades, there are still fields where females are grossly underrepresented. For instance, in 2010, women earned less than 30 percent of doctorates and master's degrees in engineering and computer science (National Science Foundation, 2013). They also earned about 40 percent of master's degrees in mathematics and physical science, and 30 percent of PhDs in these fields (National Science Foundation, 2013). Similar patterns emerge when both race and gender are considered. Relative to their male counterparts, females from underrepresented minority groups are well represented in fields such as psychology and biology. However, they remain underrepresented within other STEM areas (e.g. physics, computer science and engineering) (National Science Foundation, 2013).

The issues concerning the STEM pipeline not only present challenges for students who are traditionally underrepresented in these fields, but also pose a potential threat to the future of America's economic competitiveness and the sustainability of its 20th century position as one of the world's global powers (e.g., Bowman & St. John, 2011; National Research Council, 2007, 2009). To help address issues concerning student representation in STEM fields, a number of pipeline interventions have been developed to facilitate students' success in these areas (Chubin, DePass & Blockus, 2010; DePass & Chubin, 2009; Fagen & Labov, 2007; George, Neale, Van

---

[1] While psychology has not been consistently recognized as a STEM field, it has been acknowledged as such by leading organizations that focus on issues in STEM fields such as the National Science Foundation and National Institutes of Health. Also, the American Psychological Association has promoted psychology as a core STEM discipline (American Psychological Association, 2010).

Horne & Malcolm, 2001). In fact, from 1995 to 2005, the number of research opportunities implemented to promote undergraduate student interest in science and technology increased fourfold (SRI International, n.d). These developments are aligned with the Boyer Commission Report (1998, 2002) which encouraged institutions to make research experience a critical part of undergraduate training. Accordingly, a number of institutions have expanded their curriculum to include a research component (Katkin, 2003). As a result of this increase, discussions have emerged concerning the need to improve our understanding of these interventions, with a particular emphasis on investigating how and why they influence student outcomes.

While a number of STEM interventions have been put into place to address issues with the pipeline from K-12, undergraduate, graduate and postdoctoral levels to careers in STEM, we still have very little theory-driven knowledge about the various factors that influence the efficacy of exemplary programs and interventions. Evaluation studies have supported the overall efficacy of pipeline interventions, but less is known about the factors that ***impede*** or ***enhance*** the success of various program participants. As a result, there is a growing collaboration among several governmental agencies and non-profit organizations to support more comprehensive approaches to understanding and improving pipeline interventions that promote success among underrepresented groups in STEM fields. This collaboration has resulted in a series of conferences, workshops, white papers, research projects, and policy initiatives supported by the National Institutes of Health, National Science Foundation, National Academies, American Association for the Advancement of Science, and other partners (DePass & Chubin, 2009; Olson & Fagen, 2007). These efforts highlight a policy-relevant need to increase our holistic understanding of the conditions under which these programs have different influences on students' college and career outcomes (e.g., Bowman, 2011; Bowman & St. John, 2011; DePass

& Chubin, 2009; Olson & Fagen, 2007). In order to fully explicate the mechanisms by which programs can promote college success (i.e., academic achievement, graduate study, etc.), research must further clarify the operation of other important student characteristics which also influence college outcomes. This level of nuance requires a comprehensive look at how these programs influence participants' outcomes, given other important factors that also impact student success in college and beyond.

Guided by a strength-based role strain and adaptation model, this dissertation seeks to better clarify how financial and academic factors (i.e. financial and academic strains) influence the efficacy of innovative pipeline interventions on STEM career-related plans for underrepresented students[2] (e.g. Bowman, 2006, 2011). This research focuses specifically on students' plans to pursue research careers in STEM (i.e. *advanced* STEM career plans) given the policy interest in expanding opportunities in research and faculty careers for underserved groups in these fields. Student role strain is defined as the objective difficulties that individuals face in their role as students, as well as the affiliated cognitive/subjective appraisal of those difficulties (Bowman, 2006). A number of policy-related studies have demonstrated the deleterious effects of role stain on successful outcomes with regard to the objective financial and academic challenges that many students encounter in college (e.g., Braunstein, McGrath & Pescatrice, 1999; Hearn, 1988; Rose & Betts, 2001; St. John, 1991; St. John, Musoba, Simmons, & Chung, 2002). However, the present study goes beyond existing research to also examine: (a) how students' subjective appraisals of objective barriers (i.e. subjective threats) might further add to the deleterious effects of strain on their advanced STEM career plans; and (b) how such deleterious

[2] This study focuses on underrepresented students of color and lower-income students. Also, because women are underrepresented in many STEM fields, gender disparities in students' plans to pursue STEM research careers are also examined.

effects might be offset, mitigated or buffered by the multilevel strengths that students bring to intervention settings. As a result, this research provides a holistic view of how both objective barriers and subjective threats can deter positive outcomes for students. Furthermore, unlike most policy-relevant studies that focus narrowly on barriers, this theory-driven research also investigates the role of students' adaptive strengths on positive outcomes in addition to role strain. Because students from underrepresented groups often suffer from educational opportunity barriers and limited financial resources, it is important to consider such challenges when seeking to better understand these students' experiences and outcomes in pipeline interventions. Furthermore, it is also imperative to consider the various strengths that underrepresented students bring to intervention settings which help to promote positive outcomes. Each of these factors could have a lasting impact on how students engage the intervention and their success in college and beyond.

Given this context, I utilize a rich set of survey data from an exemplary pipeline intervention and conduct a series of analyses to investigate the following research questions:

1) Do financial and academic challenges (objective barriers and subjective threats) represent distinct dimensions of student role strain for underrepresented students in exemplary pipeline interventions?

2) Do measures of family support and personal resiliency emerge as distinct indicators of multilevel strengths for underrepresented students in exemplary pipeline interventions?

3) Do race and gender differences exist with regard to student role strain and multilevel strengths in exemplary pipeline interventions?

4) How do pipeline intervention participation, student role strain, and multilevel strengths relate to students' advanced STEM career plans?

5) Do exemplary pipeline interventions moderate the relationship between objective and subjective student role strain and students' advanced STEM career plans?

6) Is the relationship between student role strain and advanced STEM career plans buffered by students' multilevel strengths?

To provide context for these research questions, in the next chapter I discuss both empirical and theoretical literature concerning various factors that influence student success. I use this literature as the foundation for a conceptual model which outlines how student role strain and multilevel strengths combine with intervention experiences to influence intervention outcomes. In Chapter III, I discuss the methodology used for this study, including the study overview, research setting, research design, sample, data collection techniques, measures, data analysis procedures and limitations. In Chapter IV, I outline the study findings with regard to the previous research questions. Finally, Chapter V discusses the implications of this research with regard to better understanding the mechanisms that impede and promote intervention efficacy. I also offer insight about how interventions can increase the pipeline to research careers for underrepresented students based upon my findings.

CHATER II

LITERATURE REVIEW

This dissertation expands existing literature concerning STEM interventions by using a social psychological framework to understand how interventions combine with other important factors to influence successful student outcomes in STEM. In this chapter, I begin with an overview of the literature concerning race and gender disparities in STEM fields. This information gives the reader some insight about the magnitude of the issue concerning STEM participation for these students. Afterwards, I discuss the literature concerning interventions designed to promote college success in STEM fields and to bolster the STEM pipeline. Next, I outline literature regarding other important factors that also influence college outcomes in addition to intervention participation. While much of this literature is not STEM specific, it provides useful insights about some of the challenges afflicting students in these and other fields. I begin with a discussion of financial barriers that many students in college encounter and how these issues can have deleterious effects on outcomes. I also note the role of public policy in helping to reduce these financial challenges. In addition to financial barriers, I also outline key literature concerning academic preparation and its influence on various college outcomes. Afterwards, I discuss the various multilevel strengths that students can draw from to promote positive college outcomes, with a particular emphasis on personal resiliency and family support. Finally, I discuss the Bowman Role Strain and Adaptation Model (BRSAM) and its utility with understanding (1) how both objective barriers and subjective threats influence student outcomes and (2) the positive relationship between students' multilevel strengths and these outcomes.

Furthermore, guided by existing empirical evidence and the BRSAM, I outline the conceptual framework guiding this research.

Science, Technology, Engineering and Mathematics (STEM) Participation

Overall, there has been a growing focus on increasing student participation in STEM. Furthermore, there is a pressing need to decrease racial/ethnic and gender representation disparities in these fields. To facilitate this process, many colleges and universities have implemented STEM interventions designed to increase students' interest, participation and educational advancement in science, technology, engineering and mathematics. In the following sections, I provide contextual information about STEM participation across gender and race/ethnicity. I also discuss the existing empirical evidence concerning how these interventions influence student outcomes with a particular emphasis on how these programs influence post-baccalaureate plans.

Gender Disparities in STEM. Men continue to outnumber women in many STEM fields, although the number of women in these fields is increasing. Underrepresentation issues for women continue even though a comparable number of women and men obtain the high school academic preparation necessary to pursue STEM majors in college (Adelman, 1999; Hill, Corbett & St. Rose, 2010). The gap between women and men amongst STEM majors is also reflected by gender differences amongst graduates in many science and engineering fields. Furthermore, the gap expands at the graduate level and in terms of representation in the STEM workforce (Beede, Julian, Langdon, McKittrick, Khan & Doms, 2011; Blickenstaff, 2005; Hill, Corbett & St. Rose, 2010).

There is an ongoing research agenda to determine the factors that contribute to the gender gap in many STEM fields. Some have argued that the gender disparities in the sciences are due to biological factors. In fact, Lawrence Summers, the former president of Harvard University, publicly remarked that fewer women are represented in the sciences due to gender differences in ability or aptitude (Bombardieri, 2005). While some studies have suggested that women have a lower competence for science fields due to biological factors, this perspective has become quite controversial and various research has provided alternative explanations (Blickenstaff, 2005; Brainard & Carlin, 1998; Cole & Espinoza, 2008; Hill, Corbett & St. Rose, 2010). Other studies indicate that environmental factors play a major role in the gap that persists in college and beyond. A recent study by the American Association of University Women (AAUW) (Hill, Corbett & St. Rose, 2010) suggests that there is an implicit unconscious tendency to impose a gender orientation on certain fields with STEM fields being considered “male” and humanities “female.” This bias is often projected inadvertently even by those that otherwise reject these stereotypes. Also, the study indicates that women in “masculine” fields are assumed to be less competent unless they have proven themselves to be successful. However, when women are successful in these fields, they are perceived as less likeable (Hill, Corbett & St. Rose, 2010). Each of these factors has a deleterious effect on female representation in STEM.

Environmental factors which manifest during early educational stages also influence ultimate female representation in many STEM areas. This includes stereotypes that negatively impact girls’ math and science achievement and their aspirations to pursue careers in the sciences and engineering (Blickenstaff, 2005; Hill, Corbett & St. Rose, 2010). Additionally, research indicates that, despite similar test scores in mathematics, some girls believe that their skill levels are lower than their male peers. Furthermore, evidence suggests that many girls also believe that they have to overcome exceptional gender-related hurdles in order to succeed in science fields which are dominated by men (Hill, Corbett & St. Rose, 2010)

Given the relatively low representation of women in many STEM fields, some scholars have begun to investigate the factors that promote the persistence and academic performance of women who initially pursue STEM majors. Contrary to popular belief, research suggests that women who leave STEM majors do not do so because of academic difficulties. Brainard and Carlin (1998) conducted a longitudinal study of persistence among female science and engineering majors at the University of Washington to better understand the factors that influence this outcome. After examining various factors that influence college persistence, this study indicated that there were no differences found in college achievement between women who remained in the sciences and those who transferred out. Accordingly, the authors suggest that other factors were responsible besides academic performance. These include academic discouragement, educational climate challenges, perceptions of low grades, science self-confidence issues, and change of interests. Other studies support the finding that women who leave STEM do so for reasons other than poor academic performance (Adelman, 1999).

While research suggests that women do not leave STEM majors because of low academic performance, preparation and achievement do positively influence persistence in these fields. Griffith (2010) has used large-scale, national datasets and examined persistence in STEM majors to both the sophomore and senior years in college. The research indicates that, for women, high school academic preparation positively influenced persistence in a STEM major to the sophomore year. Early college academic performance was also positively related to persistence in a STEM major to the sophomore and senior years, but this relationship was stronger for sophomore STEM persistence. STEM major persistence during the sophomore year was also influenced by institutional characteristics. For example, at selective colleges and universities, women were more likely to persist at institutions which had no graduate programs or more undergraduates relative to graduate students.

Racial Disparities in STEM. With regard to underrepresented students of color, Cole and Espinoza (2008) used longitudinal data from Cooperative Institutional Research Program (CIRP) to investigate the factors that influence academic performance for Latino students in STEM fields. This research disputed differences in competence between women and men in STEM fields. The findings suggested that although Latinas were less likely to major in STEM fields, those that did reported higher grades than their male counterparts. Furthermore, high school grades and support/encouragement from faculty were positively related to Latino(a) students' academic performance in college.

As previously noted, minority students are underrepresented amongst the pool of graduates in STEM fields, as well as the resulting STEM workforce (National Action Council for Minorities in Engineering, 2008). The reasons for this disparity are multifaceted. Despite popular opinion to the contrary, some research suggests that representation issues are not due to a lack of interest in sciences amongst underrepresented students of color upon entering college (Anderson & Kim, 2006). One important factor examined in the literature is limited access to academic preparation prior to college enrollment (e.g. Anderson & Kim, 2006). Additionally, it is also important to consider lower persistence and graduation rates for underrepresented minorities—especially in STEM fields (Alexander, Chen & Grumbach, 2009; Anderson & Kim, 2006; Grandy, 1998). Using administrative data for 15,000 students from six colleges in California, Alexander, Chen and Grumbach (2009) examined differences in college persistence in gateway courses for medical and dental school. The results indicated that, after controlling for important factors such as high school quality and college admission test scores, underrepresented students of color were more likely to earn lower grades in college prehealth gateway courses than their majority peers. However, minority students were almost equally likely to persist in completing at least four gateway courses during their matriculation.

While Alexander and colleagues (2009) examined persistence in gateway courses for medical professions and suggested similar persistence rates, other research indicates that differences in persistence and graduation rates contribute to the limited supply of minorities in STEM fields. Using data from the Beginning Postsecondary Students Longitudinal Study and a nationally representative sample of undergraduates at four-year institutions, Anderson and Kim (2006) examined differences in persistence between underrepresented minorities, Whites, and Asian American students. The descriptive results indicated that African American and Hispanic students enter college as STEM majors at rates similar to Whites and Asian American students and persist initially, but graduate at lower rates within six years (Anderson & Kim, 2006). Students who initially declared STEM majors persist through the first three years of college at similar rates across racial/ethnic groups. However, disparities emerge after the third year as African American and Hispanic students graduate from these fields at lower rates than their White and Asian American peers.

From an institutional perspective, Bonous-Hammarth (2000), used data from the Integrated Postsecondary Education Data System (IPEDS) and the Cooperative Institutional Research Program (CIRP) to examine how personal and organizational factors influence student retention in STEM majors. In this analysis, the author suggests that the limited number of students in STEM fields is partially because more students are leaving STEM majors while they are in college than the number of students that are opting into these fields after initial enrollment.

Furthermore, underrepresented minorities are the largest group of students who “leave” STEM fields, and the smallest group of students who migrate into these areas. Bonous-Hammarth (2000) notes that pre-college success (i.e. high school GPA and SAT math score) is positively related to continuous enrollment in STEM fields for minorities. Also, early intentions of majoring in a STEM field were positively related to retention.

Because of the potential for pre-college academic preparation barriers to impede successful outcomes in STEM fields, some scholars have endeavored to understand the factors that influence persistence amongst high achieving minority students who have had greater access to educational resources. For example, Grandy (1998) examined the factors that influence the persistence of high-ability minority students in the sciences. The author restricted the study to minority students who earned high math scores on the SAT in order to focus the analysis on students with the prior academic training necessary to pursue science degrees and careers. In addition to data from the SAT and the affiliated Student Descriptive Questionnaire, the author also employed survey methods to gather additional information about students two years and five years following high school graduation. Structural equation modeling was used to fully examine how various factors influence persistence directly and indirectly. The results indicated that while high school achievement in math and science had a significant indirect influence on persistence even amongst high achieving minority students, affective characteristics such as students’ ambitions, degree of commitment to the sciences, and access to support from other minorities were stronger determinants of persistence in the sciences. With regard to gender differences, high achieving minority women were less likely to persist in the sciences compared to their male counterparts. Similar to other research (Brainard & Carlin, 1998), the author indicates that factors besides academic achievement influenced women's lack of persistence (e.g., lower levels of science ambitions).

STEM Pipeline Interventions. Given the need to establish a diverse pool of students in STEM, a number of policy initiatives have been developed to increase students' interest, participation, and educational advancement in these fields. For example, the White House Educate to Innovate Initiative was implemented to enhance the United States' national capacity in STEM. This initiative promotes STEM teaching improvements, partnerships with the private sector, federal investment in STEM, and efforts to diversify these fields (White House, n.d.). Similarly, the Association of American Universities Undergraduate STEM Education Initiative was launched to improve teaching and learning in STEM at the college level (Association for American Universities, n.d.).

At the institutional level, many colleges and universities have developed interventions with similar ambitions to (1) increase the pipeline to STEM profession and (2) facilitate positive STEM outcomes— particularly future graduate work. Research indicates that interventions can help to promote positive college outcomes directly and indirectly for students from underrepresented groups and others (e.g. Bauer & Bennett, 2003; Hunter, Laursen & Seymour, 2006; Lopatto, 2004, 2007; Maton, Domingo, Stolle-McAllister, Zimmerman & Hrabowski, 2009; Pender, Marcotte, Domingo & Maton, 2010; Yauch , 2007).

A number of studies examine how interventions influence students' post-baccalaureate decisions. The Meyerhoff Scholars Program is a comprehensive program that has been highly praised for increasing underrepresented minority students' participation in STEM fields (e.g. Maton, Domingo, Stolle-McAllister, Zimmerman & Hrabowski, 2009; Pender, Marcotte, Domingo & Maton, 2010). It was founded in 1989 at the University of Maryland Baltimore County with an objective to increase the number of minority students that pursue a PhD in a STEM area or a MD/PhD. As of January 2013, alumni from the program have earned 108 PhDs, 32 MD/PhDs and 105 MDs (UMBC Meyerhoff Scholars Program, n.d.). Also, Meyerhoff students are about five times more likely to have earned or worked towards a STEM PhD or MD/PhD than similar peers (UMBC Meyerhoff Scholars Program, n.d., Maton et al, 2009). Using longitudinal data from the Meyerhoff Program, Pender and colleagues (2010) used multivariate techniques to investigate the relationship between summer research internships and graduate work in STEM fields. This analysis controlled for important student characteristics such as academic exposure, research characteristics and cohort effects. Overall, the results indicated that such internships are positively related to enrollment in STEM PhD programs. The magnitude of the effect differed according to the number of summers that students participated in the intervention. Also, timing was critical. Internship experiences during any summer besides the summer following the freshman year was positively related to enrollment in a STEM PhD program. Other research has highlighted positive STEM outcomes affiliated with the Meyerhoff Scholars Program (Maton et al, 2009; Maton & Hrabowski, 2004; Maton, Hrabowski, & Schmitt, 2000; Maton, Pollard, McDougall & Hrabowski, 2012).

Yauch (2007) examined how interventions influence post-baccalaureate plans for undergraduate students in industrial engineering. While the research did not focus specifically on underrepresented students, it highlighted ways in which interventions can have a positive effect on students' plans for graduate study. The author surveyed 61 alumni from the Industrial Engineering and Management (IEM) program at Oklahoma State University. The respondents were categorized as follows: (1) students who were summer undergraduate research assistants

(UGRAs) funded by the National Science Foundation (NSF), (2) enrollees in an undergraduate research methods course, and (3) alumni who graduated with IEM degrees, but did not complete the methods course or serve as UGRAs. The latter group of students served as a comparison group. The results of this descriptive analysis indicated that undergraduates with research methods training were more likely to plan to attend graduate school than their other peers in the study. Yauch (2007) also found that there was no difference in graduate school plans between UGRAs and the non-research comparison group, but noted that the financial incentive affiliated with the summer research opportunity may have resulted in sample selection bias issues. The author also noted that a small proportion of students who expressed interest in graduate work attributed that decision to the actual undergraduate research experience. However, the author suggested that the encouragement from faculty received as a result of these research experiences could play a significant role.

Similar to Yauch (2007), Bauer and Bennett (2003) also conducted a campus level analysis of how interventions influence students' plans to graduate and to pursue doctoral studies. Again, this research did not focus on underrepresented students specifically, but it indicated the positive effects that interventions can have on students' plans to pursue doctoral work. The authors surveyed 2,444 alumni from the University of Delaware which was recognized by the NSF for its longstanding, institution-wide undergraduate research program. Respondents included 865 graduates who participated in undergraduate research opportunities and were matched with other alumni who had similar characteristics (i.e., major, graduation year, grade point average (GPA)) but did not participate in undergraduate research. The authors used probit analysis and controlled for students' academic achievement. The results indicated that the undergraduate research experience increased the likelihood that students would pursue a graduate degree. In fact, undergraduate research participants had a probability of attending graduate school that was 67 percent compared to 57 percent for their peers without research experience. Furthermore, research program participants were twice as likely to pursue a PhD as non-participants.

Lopatto (2004, 2007) evaluated the Howard Hughes Medical Institute grant-funded undergraduate research opportunities programs which operated at 41 different institutions including research extensive universities, master's level institutions and colleges. The author surveyed 1,135 undergraduate students who participated in the programs during late Summer and Fall of 2003. About a third of respondents were underrepresented minorities. Similar to Yauch's (2007) research, Lopatto (2004, 2007) found that very few students without prior interest in graduate work were influenced to consider this path as a result of their research experiences. This finding is also validated by other research (Hunter, Laursen & Seymour, 2006; Russell, Hancock & McCullough, 2007). However, nearly all of the students indicated that their experiences in the programs helped to maintain or increase their interest in graduate study (Lopatto, 2004, 2007). Also, the program participants experienced gains in intrinsic motivation and active learning (Lopatto, 2007).

On an even broader scale, NSF co-sponsored a nation-wide evaluation of NSF-supported undergraduate research programs (Russell, Hancock & McCullough, 2006; Russell et al, 2007). One of the primary objectives of this research was to determine how: (1) research exposure influenced students' academic and career decisions and (2) research programs influenced student subgroups differently. A total of approximately 15,000 respondents were surveyed using web-based instruments. The sample included NSF-program participants at the undergraduate, graduate, postdoc and faculty levels, as well as a nationally representative sample for each of the following: individuals between the ages of 22 and 35 with a bachelor degree in a STEM field, and individuals between the ages of 22 and 35 with a bachelor degree in a social, behavioral or economic science. Four groups of students are considered: (1) NSF program participants, (2) undergraduates whose research programs were partially funded my NSF, National Aeronautics and Space Administration (NASA), or National Institutes of Health (NIH), (3) undergraduates with research experiences not sponsored by those agencies and (4) undergraduates with no research experience.

Similar to Yauch (2007) and Lopatto (2004), the descriptive results of this analysis indicated that undergraduate researchers in STEM fields were more likely than their non-STEM peers to develop PhD aspirations during their pre-college experiences (Russell et al, 2006). However, the authors also suggested that participation in undergraduate research opportunities increased students' interest in STEM careers, students' likelihood of actually obtaining the PhD, and their confidence in their abilities to conduct research. Those research experiences also increased students' awareness of what graduate school was like (Russell et al, 2006, 2007). Also, the author noted that, among STEM graduates, students with longer durations of undergraduate research were more likely to report expecting to obtain a PhD. However, given that many students developed these aspirations in high school or before, it is hard to disentangle the influence of program participation and pre-college expectations on student graduate degree plans. With regard to the effects of research experiences for different types of students, Russell and colleagues (2006) found that the programs' effects were the strongest for Hispanic/Latino students and the weakest for non-Hispanic Whites, although most group differences by race/ethnicity were small. There were no differences in effects by gender. In reference to self-efficacy, the authors suggest that nearly all of the students that participated in NSF-sponsored programs indicated that their experiences increased their confidence in their research skills and ability to succeed in graduate school.

Financial Role Strain: Objective Barriers and Subjective Appraisals

While each of the previous studies provided interesting information regarding how interventions promote positive outcomes in STEM fields, none of them considered how other important factors combine with interventions to influence those outcomes. In this section, I discuss how students' objective financial barriers and subjective financial threats can deter college success. Both of these factors can also influence intervention outcomes for underrepresented students—particularly those with financial constraints. The broader literature concerning these financial barriers and threats does not speak to issues in STEM fields specifically. However, it does provide insight concerning the financial strains that many students must overcome regardless of their major. Accordingly, this research provides useful information about the financial challenges that students may experience in STEM fields which can also impact intervention outcomes in addition to the intervention itself.

An early study by Goode (1960) defines role strain as "felt difficulties in fulfilling role obligations" (p. 483). Similarly, Bowman (2006) refers to role strain as "the objective difficulty, and cognitive appraisals of such difficulty, that people in highly valued life roles (student, worker, family, elder, etc.) experience" (p. 120). With this definition, Bowman highlights both the objective challenges that individuals encounter in a particular role, as well as the subjective threats that can result from those objective challenges. In doing so, the author emphasizes the importance of both the objective and subjective elements of role strain. While objective role barriers have been the primary focus of most policy-relevant studies, growing empirical and theoretical evidence also supports subjective role strain's importance, including role distress, role discouragement, role attributions, overload, ambiguity and conflict (Bowman, 2006, 2011). In addition to role strain, Bowman's comprehensive role strain and adaptation model also focuses on the importance of considering adaptive strengths that operate systematically to offset the deleterious effects of role strain.

Relating the role strain construct to the financial challenges that college students encounter, financial role strain represents the objective difficulties that students experience fulfilling role obligations because of financial constraints. This strain also includes related cognitive or subjective threats that students may encounter because of objective financial difficulties. Therefore, within the college context, financial role strain represents the objective and subjective challenges that students encounter due to financial hardships which can potentially serve as impediments to college success. Examples of these would include poverty or the lack of financial resources to pay for college (objective financial role strain) and the resulting concerns or stress about college costs (subjective financial role strain). In the following sections, I discuss objective financial barriers and related public policies designed to reduce financial burdens. I also discuss how students' subjective appraisals of these objective burdens can negatively influence college outcomes.

Objective Financial Role Strain and Related Public Policies. With recent decreases in public funding, many institutions are increasing their reliance on tuition to cover the cost of higher education. As a result, students and families are responsible for a growing share of the costs for attending college (Blumenstyk, 2011; Desrochers & Wellman, 2011). Given these funding challenges, a number of students experience considerable financial strain while attending college (e.g. Paulsen & St. John, 2002). As a result, family economic status is strongly related to college attendance (e.g. Belley & Lochner, 2007). Although some literature discusses the importance of students' subjective appraisals of financial obstacles (Brazziel & Brazziel, 2001; St. John, 2003, 2006; St. John, Hu & Fisher, 2011; St. John & Musoba, 2010), much of the literature concerning financial role strain focuses on the objective financial barriers that students face . In the policy-relevant literature, there is substantial empirical evidence that objective financial difficulties often impede college success (e.g., Braunstein, McGrath & Pescatrice, 1999; Millet, 2003; Paulsen & St. John, 2002; Perna, 2000; St. John, Paulsen & Starkey, 1996). Accordingly, various policies have been implemented to address these issues and to help improve college outcomes—particularly for lower-income students. For instance, within the literature, there is evidence that some grant aid improves students' opportunities to attend college—perhaps even more than other forms of student financial aid (Dynarski, 2003; Leslie & Brinkman, 1987; Schwartz, 1985, 1986). The literature also suggests that the impact of means-targeted grants on college access is more prevalent for students from lower-income families than for students who have greater financial resources (Leslie & Brinkman, 1988; St. John, 1990; St. John & Noell, 1989). With regard to enrollment by race, there is evidence that grants can increase the college participation of underrepresented minorities—particularly Black students (Jackson, 1989, 1990; St. John & Noell, 1989).

It is important to note that grants come in different forms. Most grant aid programs generally fall into one of two categories—need-based and non need-based aid. While non need-based aid is generally merit-based and does not specifically target students who struggle financially, need-based aid is designed to help alleviate some of the financial burdens that lower-income students experience in college. Accordingly, need-based financial aid is particularly germane to the discussion of objective financial role strain. In terms of federal need-based aid, the literature concerning the Pell Grant is mixed with regard to how this form of aid has influenced access for lower-income students (Clotfelter, 1991; Gladieux, 1983; Hansen, 1983; Kane, 1999; Manksi & Wise, 1983; McPherson & Schapiro, 1991, 1993, 1998). These disparities may be due to methodological differences in the research and changes in Pell funding over time. At the state level, the literature concerning need-based aid consistently indicates that this form of public spending produces positive outcomes in college participation. At both the federal and state levels, there is evidence that the influence of need-based aid varies by income level with lower-income students benefiting the most (Jensen, 1983; Leslie & Brinkman, 1988; Manksi & Wise, 1983; McPherson & Schapiro, 1993, 1998; St. John & Chung, 2006). Few studies examine the influence of need-based aid on college access for underrepresented students. However, studies that focus on this topic suggest that this form of assistance has helped to open doors for these students (e.g. Kane, 1994). Also, research that considers overall enrollment patterns substantiates this relationship (Heller, 1997, 1999).

In addition to strictly need-based and non need-based student aid, there are also policies emerging at the state level which incorporate both need and academic merit components (i.e., hybrid student aid programs). While the Pell Grant and similar need-based aid programs are based on income, hybrid aid programs target lower-income students who meet some specific academic benchmarks. Accordingly, these programs are designed to reduce financial role strain for students who have exhibited a particular level of academic achievement. Examples of these programs include the Twenty First Century Scholars Program and the CalGrant Program (St. John, Fisher, Williams & Daun-Barnett, 2008; St. John, Musoba & Simmons, 2003; St. John, Musoba, Simmons & Chung, 2002; St. John, Musoba, Simmons, Chung, Schmit & Peng, 2004). Overall, the research indicates that, unlike non need-based grant programs where eligibility is strictly based on indicators such as standardized test scores, hybrid programs have provided a more efficient means for expanding college access for lower-income students and underrepresented minorities (Kane, 2003; Musoba, 2004; St. John, 2004; St. John, Musoba, Simmons & Chung, 2002).

Subjective Financial Role Strain and College Outcomes. While much of the financial aid literature focuses on objective financial barriers, there is some literature that acknowledges students' subjective responses to objective barriers by discussing how college cost concerns influence success (Brazziel & Brazziel, 2001; St. John, 2003, 2006; St. John, Hu & Fisher, 2011; St. John & Musoba, 2010). For lower-income students, these concerns manifest at earlier stages along the education continuum as students begin to prepare for college (U.S. Department of Education, 2002). As a result, programs such as the Washington State Achievers, Gates Millennium Scholars and the Twenty First Century Scholar Program were established to expand college opportunities for lower-income students. These programs provide financial aid to alleviate concerns about college costs that can hinder students' plans, preparation for and success in higher education (St. John, Hu & Fisher, 2011). The literature regarding college cost concerns represents an emerging body of work which highlights how students' cognitive appraisals of objective barriers can negatively influence outcomes.

The Advisory Committee on Student Financial Aid (2010) provided additional insight concerning how students' subjective reactions to financial barriers negatively influence college access and degree attainment. This policy report focused on students who at least met the minimal requirements for college attendance, and the data suggested that college-qualified students from low and moderate income families attended college and graduated at decreasing rates overtime. From 1992 to 2004, initial enrollment rates at four-year institutions decreased from 54 percent to 40 percent for low-income students, and from 59 percent to 53 percent for students from families with moderate incomes. The research suggested that the cause of this drop was largely due to college cost concerns. In 2004, 88 percent of parents and 73 percent of students from low-income families indicated that financial aid was very important in the college decision-making process. These estimates were 77 percent and 61 percent for parents and students from moderate-income families, respectively. This analysis also indicated that subjective financial role strain negatively influences college persistence. The five-year persistence rates of low and moderate-income students trailed those of their higher income peers.

St. John, Paulsen, and Starkey (1996) used data from the National Postsecondary Student Aid Study and logistic regression techniques to examine the financial nexus between persistence and choice (i.e. how the financial concerns which influence students' college selection process also impact their later persistence). The study considered college-choice decisions based upon monetary concerns and other fiscal elements such as financial aid, tuition, housing and living costs. This analysis provides some insight about how both subjective and objective aspects of financial student role strain influence within year persistence at four-year institutions (i.e. persistence from the Fall semester to the Spring semester). The research suggested that students who selected colleges largely because of concerns about low tuition costs were less likely to persist in college. There was a 1.4 percentage point decrease in persistence for students whose college selection process was driven by low tuition compared to students who did not indicate that low tuition was important. Therefore, students with higher subjective financial strain also had lower persistence. Furthermore, controlling for other important factors, increases in tuition, housing, food and travel costs negatively influenced student persistence. Given that increases in these costs represent increases in students' objective financial role strain, these findings also provide support for the deleterious effect of these barriers on successful college outcomes.

Informed by financial aid research, the student persistence literature provides some insight about the influence of objective and subjective financial strain on college success (Bean, 1982, 1985; Bean & Metzner, 1985; Cabrera, Castaneda, Nora & Hengstler, 1992; Cabrera, Stampen, & Hansen, 1990; Mallette & Cabrera, 1991). For instance, Cabrera, Nora and Castaneda (1992) examined how constructs from the financial aid and persistence literature relate to the college persistence process in order to provide a deeper conceptual understanding of how and why finances influence college persistence. This analysis employed structural equation modeling and institutional data from a large, commuter, urban institution. Furthermore, it included both subjective and objective aspects of students' ability to pay for college. Students' financial aid awards represented objective financial factors. Subjective factors included students' satisfaction with the amount of financial support from grants, loans, families, and employment. The authors found that both objective and subjective student finance had significant effects on persistence. These effects were mediated by other important factors such as GPA, social integration, academic and intellectual development, and intent to persist. Similar research has supported the direct and indirect influence of objective and subjective financial factors on college persistence using institutional and large-scale data sets (Cabrera, Nora & Castaneda, 1993; Cabrera, Stampen, & Hansen, 1990).

Subjective financial role strain is also important to consider in order to better understand outcomes in STEM, specifically. Brazziel and Brazziel (2001) conducted an exploratory, qualitative analysis of 12 undergraduate minority students in science and engineering to gain insight about why capable students in these fields decided not to pursue doctoral study and, instead, pursued corporate or other fields. While the authors indicated that a number of factors influenced students' decision (i.e., shortcoming in advisement, concerns about future employment opportunities, etc.), they also acknowledged that some underrepresented minorities decide not to pursue doctoral work in science and engineering because of concerns about (1) their ability to afford graduate school and (2) employment opportunities after completing graduate school. Similar research also notes that high achieving college students in STEM forego graduate school in favor of employment because of concerns about the financial debt that they incurred while completing their undergraduate education (as cited in Brazziel & Brazziel, 2001). This analysis highlights how subjective financial threats can impede successful graduate outcomes in STEM fields, even among students who are academically prepared.

Academic Role Strain: Objective Barriers and Subjective Appraisals.

Relating the role strain construct to students' academic challenges, academic role strain refers to the objective difficulties that students encounter due to a lack of academic exposure, and students' subjective appraisal of those difficulties. This includes students' limited access to the courses needed to prepare for college, as well as their cognitive reactions to those objective challenges (i.e. their beliefs about their academic skills). In the next section, I discuss the relationship between academic role strain and college outcomes, beginning with an outline of various public policies designed to address these issues. I then discuss how objective indicators of academic achievement and exposure influence college access for many students. Finally, I highlight the literature concerning subjective academic role strain and college outcomes. Although much of the literature discussed is not specifically related to underrepresented students or STEM outcomes, it highlights the academic challenges that many of these students have who pursue STEM and other fields

Academic Preparation, Public Policy and Role Strain. Students' academic role strain throughout the education continuum has the potential to impede successful outcomes in STEM and other fields (Museus, Palmer, Davis & Maramba, 2011). As a result, many states are making various reforms in their K-12 systems in order to increase academic preparation and thereby decrease students' academic role strain. The logic in support of these policies is that implementing reforms such as requiring additional math courses or exit examinations will supply students with the academic exposure needed to be successful in college. Previous research has suggested a positive relationship between students' high school preparation and their college outcomes (e.g., Adelman, 1999, 2006; DeBerard, Spielmans & Julka, 2004; DesJardins, McCall, Ahlburg, & Moye, 2002; DesJardins & Lindsay, 2008; Hearn, 1988; Horn & Kojaku, 2001; Horn & Nunez, 2000; Rose & Betts, 2001; St. John, 1991). This relationship provided the basis for the academic preparation rationale which focuses on reforming K-12 education in order to increase students' college success. This approach has been criticized for ignoring (1) how education reforms may negatively influence high school graduation rates and (2) the importance of financial aid with regard to college outcomes (St. John, 2006).

A number of policies have been implemented in support of the academic preparation rationale. St. John and Musoba (2006) noted that the following policy shifts can be attributed to states' increased focus on preparation:

- Offering honors diplomas to students who meet certain curriculum requirements
- Adopting National Council of Teachers of Mathematics (NCTM) math standards
- Increasing high school advanced placement offerings
- Increasing high school graduation requirements (i.e. requiring exit exams and more math courses)

- Encouraging students to take college admissions exams

Although these policies have often been widely implemented, they were not generally accompanied by increases in educational expenditures (St. John & Musoba, 2006).

Given the increased concerns about the relationship between high school academic preparation and college outcomes, a number of studies examine how various indicators of high school achievement influence college outcomes. Specifically, a number of scholars have considered how students' high school grade point average (HSGPA) and SAT scores are related to their college success (e.g., Adelman, 1999, 2006; DeBerard, Spielmans & Julka, 2004; DesJardins, McCall, Ahlburg, & Moye, 2002; DesJardins & Lindsay, 2008; Hearn, 1988; Horn & Kojaku, 2001; Horn & Nunez, 2000; Rose & Betts, 2001; St. John, 1991).

The predominant perspective of the literature suggests that students' achievement and academic exposure in high school provides a fairly good indication of their later success in college. For example, DeBerard, Spielmans and Julka (2004) surveyed 204 freshmen undergraduate students at a private, west coast university and used multiple linear regression to examine how prior academic achievement influenced college grade point average (CGPA). Unlike previous studies that focused primarily on prior academic achievement, these authors used a multidimensional model that also considered the various risk factors related to student success in college. In addition to high school achievement, the authors also considered various psychosocial factors in their analysis including quality of life, social support and coping. The analysis indicated a significant, positive relationship between students' prior academic achievement and CGPA. Specifically, for each unit increase in students' HSGPA, the CGPA increased by .52 points. Similarly, a unit increase in SAT total score increased CGPA by .14 points. The authors also noted that while social support had a positive influence on college achievement, coping mechanisms that focused on self-blame had a negative influence on achievement. One average, the CGPA increased by .11 points for each unit increase in social support. Also, the CGPA decreased by .14 points for each increase in the self-blame coping measure.

Although, in general, students' HSGPA and SAT scores help to predict their success in college, a lot of controversy surrounds the excessive focus on standardized test scores in the college selection process. This is largely due to:

- Positive correlations between SAT score and family income (Graham & Husted, 1993; Supiano, 2009)
- Gap in scores across various racial/ethnic groups (Gose & Selingo, 2001; Hacker, 1992; Jencks & Phillips, 1998; Supiano, 2009)
- A systematic lack of opportunities and resources that many students encounter in high school which affect their ability to prepare for standardized tests (Ferguson, 1998; Jencks & Phillips, 1998)
- Standardized test scores being used as indicators of school quality; thus, students who attend poorer quality schools are inadvertently disadvantaged in the college admissions process (St. John, 2011).

Despite the controversy concerning standardized testing, many institutions continue to rely heavily on SAT and ACT scores when crafting their incoming cohorts. Also, popular opinion continues to use these measures to define merit in higher education (Bollinger, 2002; Kirn, 2009; Salins, 2008). Given the positive relationship between standardized test scores and the opportunity structure within high schools, the scores can provide good indicators of the academic role strain that students bring with them as they pursue higher education.

Subjective Academic Role Strain and College Outcomes. The general slant of the literature suggests that students who take more difficult classes in high school (i.e., those with higher levels of academic exposure and lower levels of objective academic role strain) are more likely to be more successful in college. For example, Hearn (1988) used multivariate linear regression techniques and data from High School and Beyond to determine the differences in enrollment between students who completed a college preparatory track in high school and those who completed a general or vocational track. This research controlled for various other student characteristics (race, gender, SES, number of siblings, etc.) and the results indicated that students completing a college preparatory track instead of a vocational and general education track improved the probability of college attendance between .16 and .20. The level of improvement depended on the enrollment timeframe considered in the analysis and the type of institutions included. Other studies have also indicated that high school academic preparation is positively related to college enrollment (Horn & Nunez, 2000; King, 1996; St. John, 1991), persistence (Horn & Kojaku, 2001) and degree attainment (Adelman, 1999, 2006; Rose & Betts, 2001).

While studies concerning high school preparation provide insight about objective academic barriers, the literature pertaining to academic stress illustrates how subjective academic threats can negatively influence college outcomes. Smedley, Myers and Harrell (1993) used a multidimensional stress coping model and hierarchical regression analysis to examine how stress that is specific to minority groups influences college academic achievement. The authors used survey data from a large, predominantly White institution for their analysis. The questionnaire was administered to freshman students and included information about a number of academic, psychosocial and background characteristics. The final analysis sample included 161 minority students. The results of the research illustrate how both subjective and objective academic role strain can negatively influence college outcomes for students of color. The research suggested a positive relationship between prior academic preparation (i.e., HSGPA and SAT score) and CGPA. Thus, students with lower objective academic barriers experienced higher levels of achievement in college. The authors also noted that the subjective academic threats experienced by minority students in particular (i.e., strain related to academic achievement) had a deleterious effect on college achievement even after accounting for other aspects of role strain that all students may encounter. This relationship remained after controlling for objective academic role strain (i.e., prior academic achievement).

Struthers, Perry and Menec (2000) examined the relationship between subjective academic threats and college success. The authors used structural equation modeling to examine the influence of academic stress, motivation and coping styles on college performance. This study included 203 college students from various disciplines who were enrolled in an introductory psychology class. Subjective academic role strain was defined in terms of the degree of academic stress that students experience (i.e., feeling worried, helpless or stressed about their academic performance). The research suggested that subjective academic role strain has a direct inverse relationship with college achievement. The authors also noted that the influence of academic stress on college performance is mediated by students' emotion-focused and problem-focused coping strategies, as well as motivation. Other literature supports the negative relationship between subjective academic threats and college academic performance, but suggests that this relationship is moderated by students' resourcefulness (Akgun & Ciarrochi, 2003).

Multilevel Strengths: Personal and Family

Literature suggests that personal resiliency and family support are strengths that can promote successful college outcomes for underrepresented students. The empirical evidence indicates that indicators of personal resiliency such as self-efficacy (Rutter, 1987) positively influence various college outcomes including academic performance, STEM major choice and STEM degree goal-orientations (e.g. Aitken, 1982; Brainard & Carlin, 1998; Chemers, Hu & Garcia, 2001; DeBerard, Spielmans & Julka, 2004; Lent, Brown & Larkin, 1984, 1986; Zimmerman, Bandura & Martinez-Pons, 1992). These relationships exist even when accounting for prior academic achievement (Chemers, Hu & Garcia, 2001; Lent, Brown & Larkin, 1984, 1986; Zimmerman, Bandura & Martinez-Pons, 1992). The literature also suggests that community support positively influences college outcomes (Aitken, 1982; Brainard & Carlin, 1998; DeBerard, Spielmans & Julka, 2004). This includes support from family, friends, and significant others. However, the findings are somewhat mixed concerning the relationship between social support from peers and successful college outcomes (Aitken, 1982; Brainard & Carlin, 1998). This is likely due to the varying nature of peer interactions on college campuses. The following sections outline the literature concerning personal and family strengths and how they relate to positive outcomes in college. Given the relationships between multilevel strengths and student outcomes discussed in the literature, the evidence suggests that interventions which emphasize the development of these strengths may be more efficacious than those which lack such an emphasis.

Personal Resiliency. Personal resiliency is defined at a person’s ability to bounce back and thrive in the face of adversity (Bowman, 2013). A number of scholars have studied resiliency among underrepresented students of color and how it has contributed to their abilities to attain academic success (e.g. Floyd, 1996; Gonzales & Padilla, 1997; McGee, 2009). Each of these scholars note that students of color have been able to employ protective mechanisms to achieve their academic goals when confronted with adversity. Given the positive relationship between resiliency and academic success, many scholars have endeavored to better understand the characteristics of resilient students from underrepresented groups and the factors that promote these students' resilience.

Gonzales and Padilla (1997) employed survey research methods, t-tests and analysis of variance to examine the factors that contributed to academic resilience among high school students who self-identified as Mexican, Mexican American or Chicano in three California high schools. Resilient students were defined as those with self-reported grades that were mostly A's. The results of this analysis indicated that resilient students reported having higher levels of perceived support in academic environments, and a sense of belonging to school. More specifically, resilient students indicated more family and peer support, feedback from teachers, and positive ties to school. Resilient students also placed a higher value on school and had a greater sense of belonging amongst peers.

Floyd (1996) studied a similar phenomenon among African American high school students in particular. This research focused on high school seniors from impoverished backgrounds and the protective mechanisms that contributed to their resiliency despite adversity. The author employed qualitative methods, interviewing 20 students who had taken at least one college preparatory class and qualified for college entrance. The author found that familial support in a nurturing home environment; support from educators and other adults; perseverance and optimism contributed to the students' success.

McGee (2009) studied resilience amongst minority students in STEM fields at the college level. This study examined the factors that contributed to the success of high achieving, Black students in mathematics and engineering, specifically. The author employed counter narrative storytelling and case study analysis qualitative methods. Twenty-three advanced undergraduate students and graduate students were included in the study. The results indicated that high academic achievement was a protective factor which helped to counterbalance risks that could potentially impede Black students' college success in math and engineering. Two types of resilience emerged among these high achieving STEM students: (a) fragile resilience where students employed high-achievement strategies that were motivated by others' expectations (e.g., challenging racial stereotypes about Black students' abilities, or appeasing parental expectations for achievement); and (b) robust resilience which was internally developed. Characteristics of students with robust resilience included developing relationships with like-minded individuals; having a genuine appreciation for math and engineering disciplines; and desiring to serve as role models for other Black students.

Family Support. Collectively, each of the studies outlined previously illustrate how personal resiliency among underrepresented students can promote academic achievement at various points along the education pipeline. In addition to resilience, the literature also suggests that family support is another strength that promotes successful college outcomes. In particular, some of the persistence literature underscores this relationship (e.g. Bean, 1980, 1982; Nora & Cabrera, 1996). Cabrera, Nora and Castaneda (1996) examined how family support influences persistence, among other factors. Specifically, the authors used institutional data from a large, southern, urban institution and structural equation modeling to investigate how encouragement from friends and family affects within year persistence directly and indirectly. The results of this analysis indicated that encouragement from family and friends had a positive influence on persistence which operated through academic integration and institutional commitment. Accordingly, this analysis highlights how such supports can positively influence college outcomes. Other studies within the persistence literature also support these findings (e.g. Cabrera, Nora & Castaneda, 1992; Cabrera, Stampen & Hansen, 1990).

A study by DeBerard, Spielmans and Julka (2004) provides additional evidence about the positive relationship between family support and college outcomes. While this research focused primarily on the relationship between various risk factors (e.g. drinking, smoking, maladaptive coping strategies) and student achievement in college, it also examined the role of social support. The authors conducted an institutional analysis of 204 undergraduate students in introductory psychology and sociology classes at a private, west coast university. The student surveys were distributed during the first week of school. The authors examined the influence of total social support (i.e. support from family, friends and significant others) on college grades. The findings indicated that support had a positive relationship on students' academic performance.

Other research also emphasized the role of family and peer support in promoting positive outcomes in college. Aitken (1982) used theory-informed structural modeling and ordinary least squares-multiple regression to explore the factors that influence student performance, retention, and other important success indicators. This analysis employed institutional data for 892 first-year students from the University of Massachusetts. In addition to data about students' prior academic achievement, the authors also used data concerning students' demographic background, academic, social and residential experiences. The results of the analysis indicated that family support had a positive influence on students' academic performance even after controlling for other important factors such as high school rank, test scores and student satisfaction. While this research suggested a positive relationship between family support and student academic achievement, the results differed for peer support. The research indicated a negative direct relationship between student achievement and social support from peers. However, the authors also noted that students' social interactions were critical elements for other outcomes. For example, these interactions had a positive indirect impact on student retention, mediated by student satisfaction.

Brainard and Carlin (1998) examined how organizational support combines with family support to encourage successful outcomes for women in STEM. The authors conducted a longitudinal study of women in engineering and science at the University of Washington and tracked students through their academic careers to examine the factors that influenced retention rates. A total of 672 students who expressed an interest in science or engineering upon college entry were included in the analysis. The authors employed step-wise logistic regression techniques. Although this analytic approach has theoretical limitations, the findings provided support for the relationships that theory suggest. Similar to previous research concerning STEM interventions, the authors' findings indicated that the Women in Engineering Program and the Society for Women in Engineering, both of which were designed to provide students with support networks, had a positive influence on female persistence in science and engineering. Additionally, family support was positively related to persistence. Collectively, these results emphasized the positive relationship between social support and success in college. With regard to personal strengths, this study also highlighted the relationship between confidence and persistence. The authors noted that the most important perceived barrier to persistence was a decrease in students' confidence. As students continued to matriculate, their confidence became an increasingly important factor for promoting persistence in STEM fields. The study also noted the negative impact that financial issues (i.e. financial role strain) can have on persistence.

Theoretical Framework: Bowman Role Strain and Adaptation Model

The aforementioned literature discussed how various factors can influence student outcomes in college including STEM interventions, financial and academic strain, and multilevel strengths. Most studies in these areas focus primarily on one of these factors without accounting for each of these elements simultaneously and their role in enhancing or impeding student success. No current research has examined how financial hardships, academic challenges and student strengths combine with an intervention to influence the STEM pipeline. Furthermore, no existing studies have examined these elements using sociological and psychological framing to better understand how they related to each other and successful student outcomes.

The Bowman Role Strain and Adaptation Model (BRSAM) (see Appendix A) is a strength-based model that provides conceptual understanding and guidance about how social psychological factors; student role strain and affiliated coping strategies; and other background characteristics can combine with an intervention to influence college and career outcomes for underrepresented students in STEM fields (Bowman, 2011). This framework builds upon a growing body of literature that highlights the role of students' strains and strengths on successful education and career outcomes (e.g. Astin, 1999; Bandura, 1986; Bean, 1985; Betz, 2007; Robbins, Lauver, Le, Davis, Langley & Carlstrom, 2004; Sedlacek, 2004; Tinto, 1993). The BRSAM acknowledges that interventions do not operate in isolation. Other characteristics that students bring to intervention settings influence the efficacy of the intervention itself. Accordingly, the model highlights that interventions function within a complex system of other important factors to influence successful student development. Specifically, the framework notes the role of structured inequalities that students experience based on their social position (i.e. gender, racial background, economic status, etc.). These background characteristics impact the normative and non-normative social psychological risks that students experience at the personal, family/community and institutional levels. Furthermore, because of these inequalities, individuals may have to overcome particular strains in their roles as students. Bowman (2006) defines student role strain as the objective difficulties that individuals face in their role as students, as well as the affiliated cognitive/subjective appraisal of those difficulties. Accordingly, the role strain construct includes the objective barriers that students face, as well as the resulting subjective threats which they may encounter.

The BRSAM notes that students can respond to role strain in multiple ways. They can adopt risky coping strategies which exacerbate existing barriers and threats. However, because the BRSAM is a strength-based model, the framework also notes that students can employ psychosocial strengths in response to role strain in order to promote positive outcomes. These strengths are also related to students' social position and come from etic (i.e. universal) and emic (i.e. culturally-relevant) resources at multiple levels including the personal and family/community levels. Furthermore, students may acquire strengths that emerge from policy/institutional resources. Each of these factors (i.e. student role strain, coping strategies, psychosocial risk factors and multilevel strengths) intermingles with the intervention experience itself to influence successful educational and career outcomes. Informed by the BRSAM, the conceptual framework in Figure 2.1 guides this analysis.

As Figure 2.1 illustrates, the framework for this analysis considers students' multilevel strengths at two levels— personal and community. Students' individual strengths are represented by personal resiliency. Resiliency is a dynamic construct that is rooted in both the physiological and psychological literature (Tusaie & Dyer, 2004). From a psychological perspective, resiliency can be broadly defined as an individual's ability to achieve positive outcomes (i.e. positive adaptation) in the face of adversity (Bowman, 2013; Luthar & Cicchetti, 2000; Tusaie & Dyer, 2004). A number of elements contribute to resiliency including personal, familial, and environmental factors (Bowman, 2013; Floyd, 1996; Gonzales & Padilla, 1997; McMillan & Reed, 1994). In addition to resiliency, this framework also considers how family support influences student success.

This study also considers academic and financial student role strain, and how these factors can influence advanced STEM career plans. As previously noted, academic role strain refers to the academic difficulties that individuals experience as students. Aligned with the role strain and adaptation framework, this includes objective barriers such as limited prior academic preparation, as well as subjective threats resulting from objective barriers such as students' lack of self-confidence about their academic abilities. Financial role strain is defined by objective financial challenges and the cognitive appraisal of those challenges that students must confront in pursuit of college success. Examples of these would be lower-income status and perceptions of financial constraints, respectively.

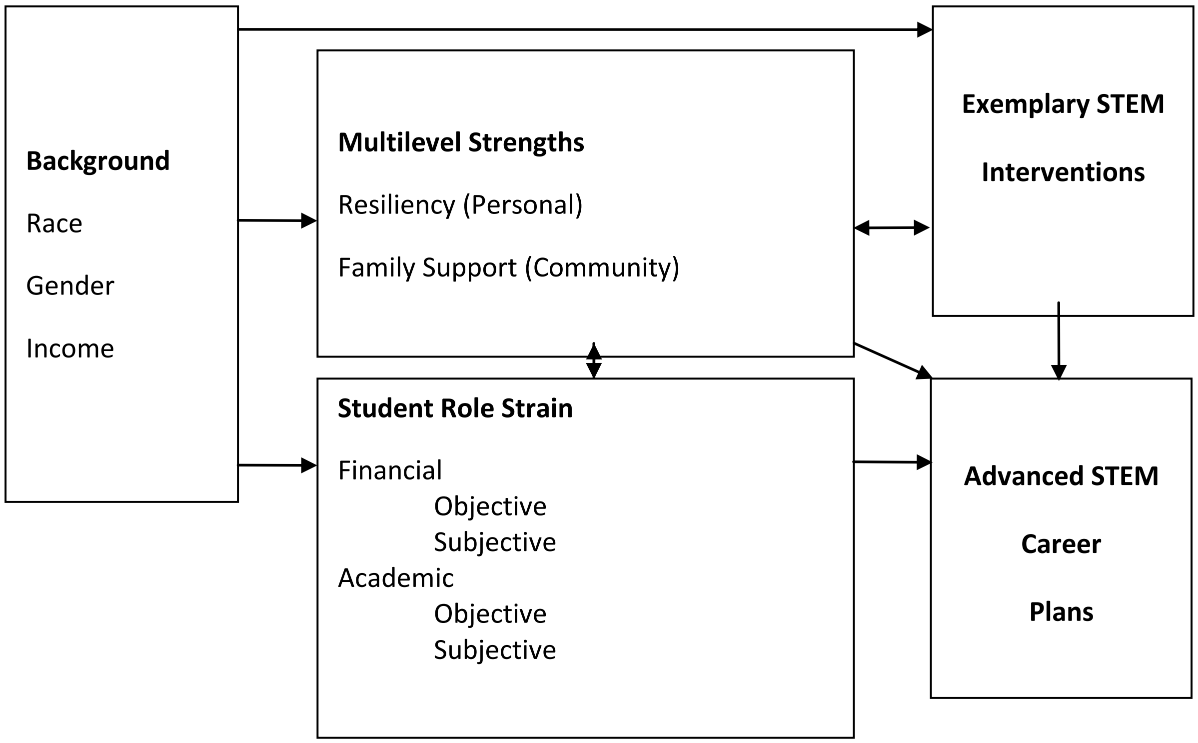


Figure 2.1. Conceptual Framework for the Influence of Multilevel Cultural Strengths, Student Role Strain and Exemplary Pipeline Interventions on Advanced STEM Career Plans

CHAPTER III

METHODOLODY

Study Overview

This study uses a subset of data collected for a broader longitudinal study funded by the National Institute of General Medical Sciences at the National Institutes of Health. The overarching study is titled "A Multimethod Study of Exemplary Research Opportunity Interventions" and the principal investigator is Dr. Phillip J. Bowman. The data for this study includes undergraduate students who applied to the Committee on Institutional Cooperation Summer Research Opportunities Program (CIC SROP) and similar research programs. Other studies have examined the influence of CIC SROP on various post-baccalaureate outcomes including professional socialization, educational aspirations and graduate study (e.g. Davis, 2005; Eatman, 2002; Foertsch, Alexander & Penberthy, 2000; Johnson, 2005).

Although CIC SROP is not an intervention for students in STEM fields exclusively, the United States White House awarded it the prestigious Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring for successfully mentoring students in these fields (Committee on Institutional Cooperation, 2008). Also, given that a number of students in CIC SROP and similar interventions study STEM areas, this research focuses specifically on a STEM-relevant outcome. Because CIC SROP and similar interventions play a prominent role in exposing students to research and potential careers in STEM, it is important to examine how these programs may affect students with STEM majors, as well as Non STEM students who may be interested in the sciences, but are on the margins in terms of their major choice and future plans. Although the broader study includes multiple cohorts, sampled in four waves, this study focuses on a single cohort and data collected at three points in time—before summer research programs began or shortly thereafter,; the fall term following the summer research program; and during the second term of the academic year. Additional information regarding the overall cohort is available in Appendix B.

Research Setting

The data for this analysis comes from the CIC SROP which was initiated in 1986 and is currently active at each of the Committee on Institutional Cooperation (CIC) Institutions: The University of Illinois at Urbana-Champaign, the University of Iowa, the University of Michigan, Michigan State University, the University of Minnesota, Northwestern University, The Ohio State University, Pennsylvania State University, Purdue University, and the University of Wisconsin at Madison. The program is also active at the University of Illinois at Chicago and the University of Wisconsin at Milwaukee.

Since its inception, the program has served over 9,000 students and its primary objective is to increase the number and diversity of students who attend graduate school and pursue research careers. CIC SROP was designed to serve the needs of students that are underrepresented in graduate education including minorities, first generation college students and those from lower-income families regardless of race. The CIC SROP targets second and third year students who have expressed some interest in pursuing a PhD. Program participants work with a faculty mentor during the summer for eight to ten weeks and reside on campus. Students are expected to work forty hours a week and receive a stipend for their participation.

Research Design

This research project resulted from a collaboration between the CIC, the CIC SROP host campuses and the National Center for Institutional Diversity at the University of Michigan. This study utilizes panel survey data measured at three points in time— before summer research programs began or shortly thereafter, immediately following the programs, and during the second term of the academic year. Survey methods were used as a primary research approach. This approach was appropriate because it provided a useful means to describe, explain and explore characteristics and relationships in a population (Babbie, 1990). Furthermore, it proved to be a more effective way to contact students in geographically dispersed areas at the various CIC institutions

In this study, all data was collected via web[3] and there were 3 waves of data collection. The data includes information concerning students' background, education and degree expectations, self-assessment of academic and leadership abilities, program experiences, educational interests, academic achievement, college preparation process, involvement on campus, and future goals. To ensure confidentiality, study participants were assigned unique identification numbers to identify students' responses across the various survey instruments.

[3] While the study focuses on data collected via web, the overarching study employed multiple data collection modes—mail, web and phone.

Research Sample

The research sample includes three types of students: (1) those who participated in the CIC SROP program during the summer of 2011 (N=196), (2) those who applied to CIC SROP and did not participate in the program, but instead participated in some other research opportunity program (OSROP) during the summer of 2011 (N=92), and (3) students who applied to CIC SROP, but did not participate in SROP or any other summer research opportunity program (No SROP; N=88). A single-stage sampling procedure was used to identify participants for the study. Both the summer research program participants and the non-participants were sampled in unity.

The sampling frame for this research came from a number of sources. The names and contact information for CIC SROP participants were obtained from the CIC central administration office and the program coordinators at the majority of participating institutions. When information was not provided by the universities, program coordinators were asked to send recruitment emails to program participants. These emails contained a link to a web-based form where students that wished to participate in the study were asked to provide their names and contact information directly to the research team.

Information about non CIC SROP students was also obtained in a similar fashion. The CIC administration office provided the names and contact information for students who applied to CIC SROP using the common application form, but did not participate. When the common application was not used, program coordinators were asked to send a recruitment email directly to the students where they could opt to participate in the study. The non CIC SROP students with and without research experiences (i.e. OSROP and No SROP) were identified based upon their responses to questions on the survey about summer research experiences. All study participants were college students who were at least 18 years old.

Data Collection

The data used for this study was collected at three time points. Data was initially collected during the summer of 2011, at the beginning of the summer research programs, or shortly thereafter (i.e. Time 1). Additionally, students were surveyed again during the fall term following the summer research program (i.e. Time 2). Finally, students were surveyed again during spring of 2012, after completing the summer research programs and the first term of the 2011-2012 academic year (i.e. Time 3). Data were collected primarily through an online survey with some telephone interview follow-ups utilized to improve response rates. Each instrument was initially pre-tested and reviewed by graduate and undergraduate students affiliated with the research team to ensure that each of the questions on the instrument was clear and ordered logically. For the 2011 survey cohort, a total of 646 students met the eligibility criteria for this study and gave informed consent to participate. At time 1, we were able to collect data from 616 students with active support from SROP coordinators at the 12 CIC campuses and a range of incentives for a 95% response rate. This included survey data from 314 CIC-SROP participants and 302 SROP applicants who applied by did not participate in SROP. The demographic characteristics of both the CIC-SROP participants and Non-SROP participants are presented in Appendix B. However, as in most longitudinal surveys, not all 616 Time 1 respondents answered all survey items at Time 2 and Time 3 which resulted in some missing data. For example, a missing data analysis presented in appendix E compares survey respondents on major research variables who are missing with those not missing on STEM Research Career Plans at Time 3 which is the major outcome variable focused on in this study.

Participation in the study was completely voluntary. Students who agreed to participate were informed that the information they provided would help the researchers to better understand the factors that influence the educational and career goals of undergraduate students who are interested in advanced graduate studies. Each of the study participants received a small monetary compensation for their participation. More specifically, students were given a total of $10 for completing 2 out of 3 parts of the survey that was distributed during the summer of 2011. Additionally, they were entered into a lottery to win $100. Students that completed each part of the survey distributed during spring of 2012 received $5 and were entered into another $100 lottery.

Measures

Figure 2.2 provides some insight about how each of the constructs in this study is measured and the relationship between constructs. This illustration compliments the more detailed discussion about operational definitions for each of the constructs which follows. Furthermore, additional information about the survey questions used to tap each of the constructs can be found in Appendix C. Information regarding variable coding is included in Appendix D. With the exception of the data concerning non CIC SROP students' other research experiences and the outcome variable, each of the items was measured at Time 1. These other survey items were measured at Time 2 and Time 3, respectively.

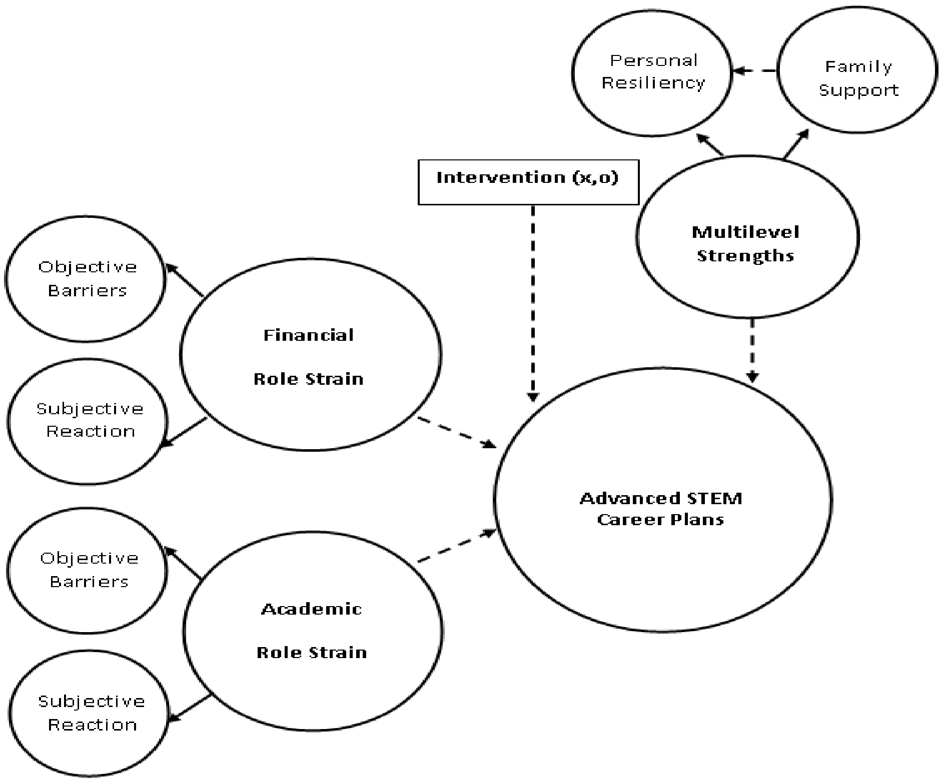


Figure 2.2. Measurement Models for Analysis

Dependent Variable: Advanced STEM Career Plans

This study investigates how exemplary pipeline interventions, student role strain and multilevel strengths influence advanced STEM career plans. More specifically, at Time 3, students were asked the degree of certainty that they would pursue a research career in some Science, Technology, Engineering, or Mathematics field. Students' responses were measured on a 5-point Likert-type scale that ranged from "completely certain I will not" to "completely certain I will." On the original measure, a lower score indicated a higher certainty about pursuing a STEM research career. Accordingly, the measure was recoded so that higher scores would indicate higher levels of certainty. Although this measure is categorical, research suggests that Likert-type scales with 5 or more items can be treated as continuous in regression analysis (i.e. Johnson & Creech, 1983; Zumbo & Zimmerman, 1993).

Intervention

As previously noted, this study uses data from the CIC SROP to identify students who participated in the CIC SROP, OSROP and No SROP. More specifically, CIC SROP students were identified using administrative data about program participants at each of the CIC host campuses. OSROP students included non CIC SROP participants who indicated some other research experience including participation in one of the following: 1) a summer research opportunities program other than CIC SROP; 2) a research internship; or 3) research methods course(s). Some OSROP students also indicated employment or volunteer work in a research related position. Dichotomous variables for CIC SROP and OSROP were created as measures of intervention effects. Students in No SROP formed the comparison group.

Independent Variables

This research employs measures from established scales to represent constructs that are prevalent in existing literature. When no such standard exists, I developed new measures using appropriate psychometric techniques. For example, no standard scales exist for subjective financial role strain. Accordingly, a new measure was derived to tap into this construct. Additionally, some existing scales were modified for increased conceptual clarity. Information about the development of new measures is available in a following section titled "Data Analysis Procedures."

Role Strain.

Financial Barriers and Threats. As previously noted, ***financial role strain*** is defined as the objective and subjective challenges that students encounter due to financial hardships which can potentially serve as impediments to college success. This construct is operationalized using items concerning students' objective financial barriers and their subjective threats in response to objective challenges. The items for objective financial role strain include information regarding: (1) receipt of college work study or Pell Grant award, and (2) family's use of public assistance. These measures have been used in other studies to quantify the financial barriers that students may experience (e.g. Flanagan & Eccles, 1993; Leventhal, Fauth & Brooks-Gunn, 2005; Maski & Wise, 1983; Orfield, 1992). With regard to financial aid, students indicated whether they received a Pell Grant, college work study, both or neither when they started college. A dichotomous variable was created to indicate student usage of these means-targeted awards. Students who received Pell and/or college work study were coded as "1" and those that did not receive either award were coded as "0."

In terms of public assistance, students indicated whether or not their families used the following during unemployment or economic hardship: (1) unemployment benefits, (2) food stamps or assistance, (3) rent or housing assistance, or (4) other types of assistance. A dichotomous variable was created where students whose families used some form of public assistance were assigned a value of "1" and those whose families did not were assigned a value of "0".

In this analysis, two measures are considered to tap subjective financial role strain. ***Financial discouragement*** is determined using a single item indicator concerning students' self-assessment of how hard they tried to keep money and other problems from hurting their school performance. Responses were measured on a 5-point, Likert-type scale from "tried very hard" to "did not try at all." Nearly half of the students indicated that they tried very hard to keep these problems from interfering with their performance. Because the original measure was positively skewed, a dichotomous measure was constructed where students who tried very hard were compared to all other students.

Students were also asked about their perceived level of *financial stress*. More specifically, they indicated the degree to which they were bothered by personal money, financial or personal job problems during the previous school year. Responses were provided on a 4-point Likert-scale from “hasn’t bothered me at all” to “bothered me a great deal.”

Academic Barriers and Threats. Similar to financial role strain, ***academic role strain*** is the objective difficulties that students encounter due to a lack of academic exposure, and students’ subjective appraisal of those difficulties. This construct is operationalized using both objective and subjective measures. This includes objective measures of prior academic preparation such as high school grade point average (GPA) and standardized test score. Each respondent indicated their overall high school GPA and the scale on which their GPA was calculated. Because high school GPAs were measured using different scales, responses were calibrated as necessary to reflect a 4 point scale. Furthermore, students’ high school GPA was recoded to better represent strain. To accomplish this, each respondent’s high school GPA was multiplied by -1 so that students with high amounts of academic strain (i.e. lower high school GPA) would have a greater value on the high school GPA indicator.

Information regarding students’ test scores was also included to operationalize objective academic barriers. Accordingly, students were asked to provide their total SAT and/or ACT scores. So that these scores were measured using a similar metric, the SAT/ACT concordance was used to convert SAT scores to comparable ACT scores when necessary. As with the high school GPA measure, the ACT indicator was recoded (i.e. multiplied by -1) to better represent academic strain.

In addition to objective academic barriers, subjective academic threats are also included in this study. Items from the Lefcourt, Von Baeger, Ware and Cox (1979) Multidimensional Multi-Attribution Causality Scale (MMCS) are used to operationalize subjective academic role strain. More specifically, the analysis uses the MMCS items which represent ***ability blame***—the degree to which students perceived that student role difficulties were caused by their own personal deficits (Bowman & Sanders, 1998). These MMCS items provide insight about the things to which students attribute their academic achievement and challenges. The original scale includes two 24-item scales that provide information about student achievement and affiliation. Both scales indicate the attributions that students make to (1) ability; (2) effort or motivation; (3) situational factors or context; and (4) luck. Twelve of the items in each scale focus on successes and the other twelve involve failures (Lefcourt, Von Baeger, Ware & Cox, 1979). Because this study focuses on academic role strain—a construct concerning the objective academic barriers that students encounter and how those challenges may influence students' subjective appraisals of their abilities— the MMCS items concerning ability attributions and failure are particularly germane. This includes students' responses to the following statements: (1) If I were to receive low marks, it would cause me to question my academic ability; (2) If I were to fail a course it would probably be because I lacked skill in that area; and (3) If I were to get poor grades I would assume that I lacked ability to succeed in those courses. Each response is measured on a 4-point scale from "strongly disagree" to "strongly agree." Responses were reverse coded as necessary so that higher scores indicated higher strain.

In addition to the MMCS (Lefcourt, Von Baeger, Ware & Cox, 1979), the Feldman (1999) index is used in this study to measure ***academic discouragement*** or student role discouragement or non-contingent response-outcome expectancy (NCROE). The items in this scale are measured on a 4-point Likert scale from “strongly agree” to “strongly disagree” and provide insight about the academic barriers that students may encounter, as well as their perceptions of those challenges, expectations, and feelings of hopelessness. When appropriate, responses were reversed coded so that higher scores indicated higher degrees of strain. The following items are considered in this research: (1) Generally, I have found my class work quite easy; (2) When my grades have been lower than expected, I have often felt discouraged; (3) I have usually been able to improve my lower exam grades; (4) If my grades don't improve, I may not pursue advanced graduate/ professional studies and just get a job; (5) I am confident that I will graduate from college; (6) Even if I tried, graduating with honors is impossible; (7) With the right strategies, I can still achieve most of the academic goals I set for college; and (8) Like many students, I will probably never achieve college grades as good as my high school grades.

Multilevel Strengths.

Personal Resiliency. As noted previously, ***personal resiliency*** is defined at a person’s ability to bounce back and thrive in the face of adversity (Bowman, 2013). Most authors have operationalized personal resiliency using etic or universal terms with a particular emphasis on a general sense of mastery or self-efficacy (Bowman, 2013); however, in this study, I utilize an emic or group-specific measure of personal resiliency developed to have particular relevance for underrepresented groups. ***John Henryism*** is defined as an “individual’s self-perception that he can meet the demand of his environment through hard work and determination” (James, Hartnett & Kalsbeek, 1983, p. 263). This scale is similar to those for self-efficacy which are often used in psychology literature. However, John Henryism has particular relevance for underserved groups (James, Hartnett & Kalsbeek, 1983). This scale was named after the legendary folklore concerning John Henry to illustrate the psychosocial challenges that African Americans in particular have to overcome in pursuit of success in different domains. Although this operationalization of personal resiliency has often been used to help to explain how active, high-effort coping can result in negative health outcomes for African Americans, James and colleagues (1983, 1984, 1994) acknowledge that the John Henry orientation can promote positive outcomes in other domains despite negative health implications. Additionally, the author notes that the John Henryism measure appears to be more sensitive to African Americans than Whites in terms of explaining how active coping influences different outcomes; however, he also notes that the scale is not limited solely to Blacks and can be used with other populations that confront similar psychosocial challenges (James, 1983, 1984, 1994). Given that CIC SROP targets underrepresented students, this emic representation of personal resiliency is appropriate. Accordingly, in this study, I use the John Henryism scale to examine how underrepresented students' perceptions about their abilities to succeed in a given context influences their STEM research career plans despite the normative and non-normative psychosocial barriers that these students must overcome in STEM fields and higher education.

As an emic indicator of personal resiliency, the John Henryism scale uses 10 items developed by James and colleagues (1983, 1984, 1994). In the scale, students were asked how well a series of scenarios describes their behavior when confronted with different challenges. These include situations such as "In the past, even when things got really tough, I never lost sight of my goals" and "I don't let my personal feelings get in the way of doing a job." Each of these items is measured on a 4-point scale from “completely false” to “completely true.” A complete list of items for this scale is included in Appendix C.

Family Support. While other studies highlight the influence of parental support on various college outcomes, this study operationalizes this construct with a measure of *extended family support.* Although Western tradition has normally identified family in terms of married heterosexual couples and their children living in the same household, many cultures define family in terms of both blood-kin and para-kin relationships (i.e., those who share familial-like bonds but may not be biologically related or live in the same household) (Reyes, 2002). This broader definition of family is often embraced by students from underrepresented groups and has been found to be particularly relevant for African Americans and Latinos (e.g. Billingsley, 1992; Reyes, 2002). Accordingly, this orientation towards family is used in this analysis to examine the influence of extended family on advanced STEM career plans. This approach recognizes the magnitude of influence that not only parents, but also grandparents, mentors, and significant others can have on student success (Cole & Espinoza, 2008; Dennis, Phinney & Chuateco, 2005; Sanders, 1998).

To assess extended family support, this study utilizes items modified from a scale originally employed by Reyes (2002). These items provide information about the perceived support towards the PhD that students received from nuclear, blood-kin and para-kin relationships. More specifically, this scale measured extended family support within three subsystems: nuclear family (i.e. parents, stepparents and siblings), intergenerational-kin (i.e. grandparents, aunts, uncles, cousins, etc.) and para-kin (i.e. other persons with whom the student shares familial-like bonds but no biological relationship). Students were asked how supportive individuals in each of those subsystems would be if they decided to pursue a Ph.D. degree. Each extended family support item was measured on a 5-point, Likert-scale including the following options: "does not apply," "not at all supportive," "somewhat supportive," "very supportive," and "extremely supportive." Additional details regarding the items included for this scale are in Appendix C.

Other Characteristics: Background and Major. Gender is measured using a dichotomous variable (1=male, 0=female). Also, measures for students' race/ethnicity are included in this study. In keeping with methods employed recently by the United States Census Bureau, students were asked two questions regarding their racial and ethnic heritage. The first question was, "Are you of Hispanic, Latino, or Spanish origin?" The second question was, "With which racial/ethnic/cultural background do you primarily identify?" The response options included: (1) African American, Black, Negro, (2) American Indian or Alaskan Native, (3) Asian American, (4) Native Hawaiian/Other Pacific Islander, (5) White, Caucasian, and (6) Other. Responses from the first question were used to distinguish students that identified as African American/Black/Negro, American Indian/Alaskan Native, Asian American, and Native Hawaiian/Other Pacific Islander. Students who identified as "Other" in the question regarding racial/ethnic/cultural background and "Hispanic" in the question concerning Hispanic, Latino, or Spanish origin were considered Hispanic/Latino in this research[4]. Once each of the aforementioned racial/ethnic/cultural groups were identified, a dichotomous variable was created to identify underrepresented students of color (0= White and Other; 1= African American/Black/Negro, American Indian/ Alaskan Native, Asian American, and Native Hawaiian/Other Pacific Islander and Hispanic/Latino).

[4] Although students from various racial/ethnic/cultural backgrounds identified as Hispanic, the majority of Hispanic students indicated "Other" for their racial/ethnic/cultural heritage.

In addition to gender and race/ethnicity, a measure for students' college major is also included in this study. Students were asked to select the field most related to their major with the following options: Biomedical/Behavioral Sciences; Other Basic or Applied Sciences (e.g. Physics, Engineering, etc.); Social Sciences/Related Professions (e.g. Sociology, law, etc.); Creative Arts/Related Professions (e.g. Theater, Art, Dance, etc.); and I have not yet chosen a college major. A dichotomous measure was created to identify STEM majors. Students whose majors were related to Biomedical/Behavioral Sciences, and Other Basic or Applied Sciences were considered STEM students and coded as "1." All other majors were considered non STEM and coded as "0."

Table 3.1 provides information about the study sample with regard to each of the measures previously discussed. These descriptive statistics suggest that CIC SROP, OSROP and No SROP students indicated STEM research career plans that were significantly different. CIC SROP students indicated the highest STEM research career plans, followed by students in other SROPs. No SROP students indicated the lowest STEM research career plans.

Overall, about 40% of students in the study came from families that used some form of public assistance during times of economic hardship. Sixty percent of students received some form of means driven financial aid, and the average ACT score was almost 26. On most of the measures for objective barriers, subjective threats and multilevel strengths, students from CIC SROP, OSROP and No SROP were statistically indistinguishable. However, there were a few exceptions. For the overall sample, the average high school grade point average was 3.68, with modest difference emerging across groups. On average, students from other SROPs had the highest high school grade point average, followed by CIC SROP students and then No SROP students.

With regard to background characteristics, there were differences in the proportion of males in each of the intervention groups. More specifically, the CIC SROP group had the highest percentage of males (36%), and No SROP had the lowest percentage of men (20%). The overall sample of students was 31% male.

There were also differences in the percentage of underrepresented students across groups. Nearly three-fourths of the students in CIC SROP were minorities, and just under 60% of the OSROP and No SROP students were minorities. Overall, underrepresented minorities are highly represented amongst the students in the study with about 67% of the sample being comprised of these groups.

In terms of major choice, 64% of all students in the sample were STEM majors, but major choice differed by group. Seventy percent of CIC SROP students were STEM majors. Sixty eight percent of OSROP students were STEM majors and under half of No SROP students were STEM majors.

Table 3.1

Descriptive Statistics by Intervention Subgroup

	All (N=376)		CIC SROP (N=196)		OSROP (N=92)		No SROP (N=88)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p
STEM Research Career Plans	3.02	1.46	3.20	1.44	3.04	1.52	2.57	1.36	**
Financial & Academic Barriers									
Used Public Assistance (dummy coded, 0=no, 1=yes)	0.41	-	0.42	-	0.41	-	0.41	-	n.s.
Awarded Pell and/or college work study (dummy coded, 0=no, 1=yes)	0.60	-	0.63	-	0.57	-	0.58	-	n.s.
High school GPA	3.68	0.49	3.68	0.47	3.78	0.56	3.59	0.47	~
ACT score	25.56	5.23	25.15	4.71	26.03	6.00	25.87	5.36	n.s.
Financial & Academic Threats									
Financial Discouragement	0.47	-	0.47	-	0.39	-	0.54	-	n.s.
Financial Stress	1.99	0.80	2.01	0.81	1.88	0.83	2.05	0.76	n.s.
Ability Blame	2.37	0.63	2.36	0.63	2.35	0.65	2.41	0.61	n.s.
Academic Discouragement	1.62	0.46	1.63	0.43	1.59	0.52	1.63	0.45	n.s.
Multilevel Strengths									
Personal Resiliency	3.19	0.37	3.19	0.37	3.21	0.37	3.17	0.37	n.s.
Extended Family Support	2.99	0.85	3.09	0.88	2.86	0.85	2.92	0.77	n.s.
Soci-Demographic Characteristics									
Male (dummy coded, 0=female, 1=male)	0.31	-	0.36	-	0.33	-	0.20	-	*
Underrepresented Minority (dummy coded, 0=no, 1=yes)	0.67	-	0.74	-	0.58	-	0.59	-	**
STEM Major (dummy coded, 0= Non STEM major, 1=STEM major)	0.64	-	0.70	-	0.68	-	0.48	-	**

SD presented for continuous variables; not relevant for dummy-coded (categorical) variables.

Data Analysis Procedures

Component 1: Psychometric Analysis of Student Role Strain and Multilevel Strengths

The first component of this study used psychometric techniques to address research questions 1 and 2, and to identify measures which represent student role strain and multilevel strengths. In particular, this aspect of the study seeks to identify items which represent objective and subjective financial and academic role strain, as well as to determine the appropriate use of existing scales to represent extended family support and personal resiliency.

As shown in Appendix C, various items were used to operationalize student role strain. While some of the items considered in this study have not been used as student role strain indicators in previous research, others come from existing scales that have been employed to create unidimensional measures within the literature (i.e. ability blame and academic discouragement). Accordingly, it was important to determine the appropriate use of these scales for this sample. To do so, a Cronbach's Alpha Coefficient was calculated as a measure of reliability. Once the investigation of internal consistency was complete, the measures were created by averaging student responses for the scale items. After measures for the existing scales were created, a correlation matrix was created to examine the relationships between these measures and other items for financial and academic student role strain. This approach was used to determine how items and measures for objective barriers and subjective threats in financial and academic domains relate to each other.

In addition to the analysis of student role strain, psychometric techniques were also used to create measures for student multilevel strengths. Because these measures have been used successfully in other studies (e.g. James, 1994; Reyes, 2002), it was sufficient to calculate

Cronbach's Alpha Coefficients to determine their appropriate use for this sample. The measures were created by averaging student responses for the scale items.

Component 2: Investigating Racial and Gender Differences

Component 2 of this research addresses research question 3. It investigates whether gender and race differences emerge with regard to (1) objective and subjective financial and academic role strain and (2) student multilevel strengths—personal resiliency and extended family support. Descriptive statistics provided some initial insight about this research component. However, appropriate statistical tests were employed to investigate group differences. T-tests were used to determine group differences on continuous measures and chi-square tests were used to examine differences on categorical indicators.

Component 3: Additive Influences of Exemplary Pipeline Interventions, Role Strain and Multilevel Strengths on Advanced STEM Career Plans

Component 3 addresses research question 4. It examines the how intervention participation relates to students' advanced STEM career plans, and the additive influences of role strain, multilevel strengths and other student characteristics on this outcome. This component also examines how the relationship between intervention participation and the outcome changes when other important factors are also considered.

Hierarchical regression analysis was used for this component. Successive linear models were examined, each including additional predictors and allowing for an in-depth analysis of how the relationship between intervention participation and the outcome changes as additional important factors are considered. The first model examined the influence of intervention participation on STEM research career plans. The second and third models considered the influence of objective and subjective aspects of financial and academic role strain on the outcome, respectively. These models illustrate how the influence of the interventions on the outcome changes once student role strain is considered, as well as the independent effects of objective barriers and subjective threats on STEM research career plans. The fourth model included measures for students' multilevel strengths (personal resiliency and family support). The next model included background characteristics. While some other studies include background information as controls in the initial step of a hierarchical regression analysis, including these characteristics as the final step allowed for a better understanding of how strains and strengths related to the outcome both before and after considering background characteristics[5]. The final model accounted for students' major. It indicated the independent effects of the intervention, student role strain, and multilevel strengths on STEM research career plans while accounting for other important student characteristics.

Component 4: Moderating and Buffering Effects of Pipeline Interventions and Multilevel Strengths

Component 4 addresses research questions 5 and 6 and provides a deeper understanding about how exemplary interventions can moderate the influence of strains and strengths on advanced STEM career plans. Research question 5 examines how pipeline interventions may moderate the influence of objective barriers and subjective threats on STEM research career

[5] While other studies have considered background characteristics as an initial step in hierarchical regression, this study employed an alternate approach for a theory-driven reason. The focus here was primarily on exploring how role strain and multilevel strengths influence intervention outcomes beyond the intervention experience itself. After exploring these theory-informed relationships, it was also important to account for students' background characteristics in the analyses. Additionally, although this study does not focus on moderating effects, observing how the influence of intervention participation, student role strain and multilevel strengths on the outcome changes in the final step of the hierarchical regression provided some initial insight about possible intervening variables (Barron & Kenny, 1986; Kenny, 2013). Overall, this information offers a more nuanced understanding of possible intervention effects.

plans. To better understand these relationships for each of the intervention groups, subgroup analyses using ordinary least squares regression were conducted to examine how financial and academic student role strain relate to the outcome for CIC SROP, OSROP and No SROP students. Additionally, moderated regression was used to determine if these relationships differed across subgroups with CIC SROP and OSROP participants being compared to No SROP students. Moreover, to address research question 6, ordinary least squares regression analyses with interaction, product, or moderator terms were used to determine how students' multilevel strengths may buffer the deleterious influence of role strain for each of the intervention groups.

CHAPTER IV

FINDINGS

In the following sections, I discuss the findings for each study component and the related research questions. I begin each section with an outline of the component and affiliated research questions to remind the reader of the central objective for the subsequent analyses. While the primary objective of this theory driven study was not to evaluate summer research interventions, a complementary discussion concerning overall intervention effects on STEM research career plans is included in Appendix F.

Component 1: Psychometric Analysis of Student Role Strain and Multilevel Strengths

Research Question 1: Do financial and academic challenges (objective barriers and subjective threats) represent distinct dimensions of student role strain for underrepresented students in exemplary pipeline interventions? The underlying objective of this aim is to examine the relationship between measures which represent financial and academic role strain. To this end, psychometric techniques were employed and bivariate relationships were calculated to identify items which represent objective barriers and subjective threats in financial and academic domains. The analyses for this research question were conducted in two parts. First, because existing scales were used in these analyses (i.e. ability blame and academic discouragement), it was necessary to determine their appropriate use for this sample. Accordingly, the Cronbach's Alpha coefficient was calculated to examine the level of internal consistency. Measures for each of the existing scales were created by averaging students' responses across the scale items.

Once the psychometric analyses of existing scales were completed, it was important to determine if the financial and academic role strain items were distinct, and if objective and subjective dimensions of role strain emerged within those domains. To do so, relationships between each of the items were examined using a correlation matrix. This approach provided information about the following: (1) the relationships between items concerning financial and academic barriers and threats, and (2) how these items can be used to represent objective and subjective role strain within financial and academic domains. The results for these analyses are discussed within different subsections.

Psychometric Analyses of Existing Scales. The constructs concerning students' subjective appraisals of academic strain are from existing scales that have been used successfully in other studies (e.g. Abouserie, 1994; Feldman, 1999; Lefcourt, Von Baeyer, Ware and Cox, 1979, Shiraishi, 2000). With regard to ability blame, this construct has been used in other studies to determine the degree to which students attribute their academic challenges to perceived ability issues. In the literature, this construct has been measured with varying degrees of internal consistency (Cronbach's Alpha from 0.58 to 0.80.) and test-retest reliability (between .51 and .62) (Lefcourt, Von Baeyer, Ware and Cox, 1979). In this study, ability blame was tapped with a fair degree of internal consistency (Cronbach's Alpha= 0.65). The measure was created by averaging students' responses across the various items.

The academic discouragement measure has also been used successfully in previous research with a high degree of reliability (Cronbach's Alpha= 0.72) (Feldman, 1999). The original scale includes 8 items which provide insight about the degree of discouragement that students may feel related to their academic performance. The Cronbach's Alpha was calculated as a measure of internal consistency and the resulting coefficient indicated that the construct had greater internal consistency when omitting two of the eight items[6]. The remaining items tapped academic discouragement with a fair degree of reliability (Cronbach's Alpha= 0.66). The academic discouragement measure was created by averaging students' responses across the various items.

Representing Objective and Subjective Role Strain. As previously noted, this research component seeks to examine the relationship between financial and academic role strain measures. As a part of this process, it is important to determine how these measures correlate. Table 4.1 provides a correlation matrix for each of the items related to students' objective and subjective, financial and academic role strain.

As shown in Table 4.1, many of the items concerning financial challenges were significantly correlated with each other. However, some items shared a stronger correlation than others. For example, indicators for Pell Grant and/or college work study award, family's use of public assistance, and money or financial problems were all positively correlated at high levels. Nonetheless, the Pell/work study and public assistance variables were more strongly correlated with each other ($r=.296, p<.001$) than with the latter indicator. This suggested that these measures were more closely related to each other than to the measure for money or financial problems. Similarly, the measure for money or financial problems was closely related to the indicator for personal job problems ($r=.433, p<.001$). Because both Pell/work study award and public assistance usage pertain to students' objective financial challenges, the evidence supported the use of these measures to represent objective financial role barriers. Furthermore,

[6] Responses to the following two survey items were excluded: Generally, I have found my class work quite easy.; When my grades have been lower than expected, I have often felt discouraged.

perceived money, financial and job problems pertain to students' subjective appraisals of objective financial barriers. Therefore, students' responses for these items were averaged to create the ***financial stress*** index which was used to represent subjective financial threats[7]. The financial stress index better represented the subjective financial role strain construct than either single item.

Many of the items concerning academic challenges were also related to each other. Specifically, ACT score and high school grade point average (HSGPA) were positively correlated ($r=.222, p<.01$). Because this study focuses on student role strain, students' high school grade point average and ACT scores were recoded to better represent strains in prior academic achievement. To accomplish this, each of these measures was multiplied by -1 so that students with high amounts of academic strain would have a greater value on the ACT and HSGPA indicators. As a result, in this study, having a higher value on the ACT indicator actually reflected having a lower ACT score. The same relationship applied for HSGPA. Given how these variables were coded, the data in Table 4.2 suggests that students with *lower* ACT scores also had *lower* HSGPAs. Although these measures were also significantly correlated with other items, the correlation matrix suggests that they were most strongly related to each other. Because these measures pertain to students' objective academic challenges, the evidence supported their use to represent objective academic barriers. Also, in relation to academic challenges, students with higher levels of ability blame were also more academically discouraged ($r= .273, p<.001$). The academic discouragement and ability blame constructs were correlated significantly with other

[7] Although the face validity of the Financial Discouragement measure would suggest that it tapped subjective financial role strain, the correlation analysis suggests that it is not strongly related to other measures which speak to perceived financial difficulties. However, the other measures concerning these perceptions are closely correlated to each other. Collectively, this suggests that the Financial Discouragement measure may not adequately tap the construct. Accordingly, it was not used as a measure for subjective academic role strain in this study.

measures in Table 4.2; however, the constructs were most strongly related to each other. Given that these constructs tap into students’ perceptions about academic challenges, the data supported the use of these constructs to represent subjective academic threats.

Table 4.1

Correlations between Financial and Academic Role Strain Items and Measures

	Awarded Pell/Work Study	Public Assistance	Financial Discouragement	Money or Financial Problems	Personal Job Problems	Lower ACT Score (a)	Lower High School GPA (a)	Ability Blame
Public Assistance	.296 ***							
Financial Discouragement	-.023	-.026						
Money or Financial Problems	.256 ***	.218 ***	.003					
Personal Job Problems	.083	.089	-.039	.433 ***				
Lower ACT Score (a)	.090	.116 ~	.070	.104	.119 ~			
Lower High School GPA (a)	-.043	.014	.048	.073	.114 ~	.222 **		
Ability Blame	-.098 ~	.080	-.050	.039	.120 *	.062	-.110 ~	
Academic Discouragement	.038	.046	-.204 ***	.095 ~	.179 **	-.106	-.146 *	.273 ***

(a) Original variable recoded to represent strain

~ p<.10; * p<.05; ** p<.01; *** p<.001

Research Question 2: Do measures of family support and personal resiliency emerge as distinct indicators of multilevel strengths for underrepresented students in exemplary pipeline interventions? As noted, some of the measures used in this study have also been successfully employed in previous research to tap the related constructs. With regard to students' multilevel strengths, the measures for extended family support and personal resiliency come from existing scales (e.g. James, Strogatz, Wing & Ramsey, 1987; Reyes, 2002). Although these measures have been used successfully in the literature, it was important to ensure that the constructs were adequately tapped for the sample in this study. To do so, Cronbach's Alpha Coefficients were calculated. Afterwards, the measures were created by averaging students' responses across each of the items related to the scale.

In previous research, various dimensions of extended family support have been operationalized to indicate the degree to which college students feel supported by their nuclear family members, blood-kin and para-kin. These constructs have been measured with a high degree of internal consistency across racial/ethnic groups (Cronbach's Alpha ranging from .68 to .81) (Reyes, 2002). In this study, extended family support was considered a unidimensional construct in order to represent the support that students receive across their family structure. The extended family support measure had a high degree of internal consistency (Cronbach's Alpha=0.87). While the original scale included 15 items, questions concerning support from siblings and an adult at the place of worship[8] were excluded to increase internal consistency[9].

---

[8] Responses to the following two survey items were excluded: How supportive would your sister be if you decided to pursue a PhD; How supportive would your brother be if you decided to pursue a PhD;

[9] This finding is aligned with previous research which also found that extended family support was measure with higher internal consistency by excluded items concerning support from sister (Reyes, 2002).

In this study, John Henryism was used as an emic form of personal resiliency. In other research, this measure has also been used with varying degrees of reliability by age and gender (Cronbach's Alpha from .66 to .74) (James, Strogatz, Wing & Ramsey, 1987). For this sample, John Henryism was measured with a high degree of internal consistency (Cronbach's Alpha=0.82). Eleven of the original 12 items within the scale were used to create the measure, with one item being omitted in order to increase internal consistency[10].

Component 2: Investigating Racial and Gender Differences

Research Question 3: Do race and gender differences exist with regard to student role strain and multilevel strengths in exemplary pipeline interventions? Component 2 examines differences in advanced STEM research career plans, role strain, and strengths by race/ethnicity and gender. The results for this component are included in Tables 4.2 and 4.3.

Racial Differences. A number of differences emerged between students of color compared to their White and Other peers (Table 4.2). Recall that in this study, students of color include the following categories:

- Blacks/African Americans
- American Indians/Alaskan Natives
- Asian Americans
- Native Hawaiians/Pacific Islanders
- Non White Latinos/Hispanics

[10] Responses to the following survey question were excluded: Sometimes I feel that if anything is going to be done right, I have to do it myself.

On average, students of color had lower STEM research career plans at Time 3 (M=2.89, SD=1.48) than their White peers and those from other racial categories (M=3.17, SD=1.37); however, this difference is marginally significant, $t(365)=1.71$, $p=.087$.

A higher percentage of the students of color in the study indicated objective financial and academic role barriers. In terms of objective financial barriers, a higher percentage of students of color came from families that used public assistance in the past compared to Whites and Others (46% vs 34%), $X^2(1, N=281)=3.78$, $p=.052$. Also, a higher percentage of students of color were awarded Pell and/or college work study (66% vs 50%), $X^2(1, N=305)=8.03$, $p=.005$.

Concerning objective academic role barriers, there were no significant differences in HSGPA across racial/ethnic categories, $t(279)=1.15$, $p=.252$. However, there were differences in ACT score. The average ACT score for students of color was almost 3 points lower (M=24.68, SD=5.01) than the average score for Whites and Others (M=27.36, SD=5.11), $t(220)=3.89$, $p<.001$. It is also worth noting that there were no significant differences in subjective role threats and multilevel strengths.

Table 4.2

Differences in Student Role Strain and Multilevel Strengths by Race

	Students of Color (N= 248)		Whites and Others (N=119)		
	Mean	SD	Mean	SD	p
STEM Research Career Plans	2.89	1.48	3.17	1.37	~
Objective Fin & Acad Barriers					
Used Public Assistance	0.46	-	0.34	-	~
Awarded Pell and/or College Work Study	0.66	-	0.50	-	**
High school GPA	3.67	0.45	3.74	0.53	n.s.
ACT score	24.68	5.01	27.36	5.11	***
Subjective Fin & Acad Threats					
Financial Stress	2.04	0.81	1.95	0.80	n.s.
Ability Blame	2.33	0.62	2.45	0.63	n.s.
Academic Discouragement	1.60	0.45	1.68	0.44	n.s.
Multilevel Strengths					
Personal Resiliency	3.20	0.37	3.14	0.32	n.s.
Extended Family Support	2.99	0.89	3.01	0.76	n.s.

~ p<.10; * p<.05; ** p<.01; *** p<.001

SD presented for continuous variables; not relevant for dummy-coded (categorical) variables

Gender Differences. The data suggested gender differences with regard to STEM research career plans (Table 4.3). On average, males reported plans to pursue research careers in STEM fields ($M=3.49$, $SD=1.38$) that were higher than their female counterparts ($M=2.74$, $SD=1.44$), $t(361)=-4.61$, $p<.001$. The males and females in the study reported similar levels of perceived strains and strengths. There were no significant differences in objective financial or academic role barriers. There were also no differences in subjective role threats with one exception. On average, females reported higher levels of perceived financial stress ($M=2.06$, $SD=.77$) than their male counterparts ($M=1.85$, $SD=.84$), $t(304)=2.15$, $p=.033$. In terms of multilevel strengths, males and females reported similar levels of extended family support and personal resiliency.

Table 4.3

Differences in Student Role Strain and Multilevel Strengths by Gender

	Males (N=113)		Females (N=250)		
	Mean	SD	Mean	SD	p
STEM Research Career Plans	3.49	1.38	2.74	1.44	***
Objective Fin & Acad Barriers					
Used Public Assistance	0.40	-	0.42	-	n.s.
Awarded Pell and/or College Work Study	0.55	-	0.63	-	n.s.
High school GPA	3.63	0.47	3.73	0.49	n.s.
ACT score	25.94	5.47	25.68	5.06	n.s.
Subjective Fin & Acad Threats					
Financial Stress	1.85	0.84	2.06	0.77	*
Ability Blame	2.30	0.71	2.40	0.59	n.s.
Academic Discouragement	1.59	0.44	1.64	0.45	n.s.
Multilevel Strengths					
Personal Resiliency	3.23	0.36	3.16	0.36	n.s.
Extended Family Support	3.06	0.89	2.99	0.83	n.s.

~ p<.10; * p<.05; ** p<.01; *** p<.001

SD presented for continuous variables; not relevant for dummy-coded (categorical) variables

Component 3: Additive Influences of Exemplary Pipeline Interventions, Role Strain and Multilevel Strengths on Advanced STEM Career Plans

Research Question 4: How do pipeline intervention participation, student role strain, and multilevel strengths relate to students' advanced STEM career plans? Prior to conducting a multivariate analysis examining how pipeline intervention participation, role strain and multilevel strengths relate to underrepresented students' advanced STEM career plans, it was important to examine the correlations between the variables of interest and the outcome. This information is included in Table 4.4. Additional information about the correlations between each of these variables is included in Appendix G.

As shown in Table 4.4, CIC SROP participation was positively correlated with STEM research career plans ($r=.135, p<.01$). OSROP participation was also positively related to the outcome, but the correlation was not significant. Additionally, not participating in an intervention (No SROP) was negatively correlated with STEM research career plans ($r=-.170, p<.01$).

In terms of objective financial role barriers, Pell and/or college work study awards were negatively related to STEM research career plans ($r=-.135, p<.05$). Furthermore, on average, students with lower ACT scores reported lower STEM research career plans ($r=-.118, p<.10$). With regards to subjective role threats, financial stress was negatively related to STEM research career plans ($r=.126, p<.05$).

Table 4.4

Correlations between Intervention Participation, Student Role Strain, Multilevel Strengths and STEM Research Career Plans

Role Strain and Adaptation Variables	STEM Research Career Plans	
Intervention		
CIC SROP	0.135	**
OSROP	0.011	
No SROP	-0.170	**
Objective Fin & Acad Role Barriers		
Used Public Assistance	-0.018	
Awarded Pell and/or College Work Study	-0.135	*
Lower High school GPA (a)	0.024	
Lower ACT score (a)	-0.118	~
Subjective Fin & Acad Role Threats		
Financial Stress	-0.126	*
Ability Blame	0.065	
Academic Discouragement	0.087	
Multilevel Strengths		
Personal Resiliency	0.049	
Extended Family Support	0.019	

~ p<.10; * p<.05; ** p<.01; *** p<.001
(a) Reverse coded to represent strain

To better understand the additive effects of intervention participation, role strain, and multilevel strengths on advanced STEM career plans, it was necessary to examine the relationship between each of the role strain and adaptation variables and the outcome within the context of a multivariate analysis. Hierarchical regression analysis was used to examine how intervention experiences, role strain and multilevel strengths influenced advanced STEM career plans overall, and how their influences may have changed as other important measures were considered in the analyses. The results are included in Table 4.5, Models 1-6. This section begins with an overall discussion about the successive models and how they account for variance in students’ STEM research career plans. Afterwards, a more detailed discussion ensues highlighting how each of the indicators for intervention participation, role strain, multilevel strengths and background characteristics relate to the STEM research career plans outcome.

Hierarchical Model Description. Model 1 in the hierarchical regression (Table 4.5) includes indicators for intervention participation. Specifically, there is a measure for CIC SROP participation, as well as a measure that represents Non SROP students with other research experience (i.e. OSROP). Non SROP students without research experience (i.e. No SROP) are the comparison group. Model 1 accounts for about 3% of the variance in STEM research career plans, which was statistically significant from zero ($p<.05$). This suggests that indicators for intervention participation help to explain some variance in the outcome.

Model 2 adds objective financial and academic role barrier indicators to the analysis. In terms of financial role strain, this model includes measures for family use of public assistance (unemployment benefits, food stamps, housing assistance, etc.), and receipt of need-based student aid (i.e. Pell Grants and/or college work study awards). With regard to academic role strain, Model 2 includes information about prior academic achievement—students' HSGPA and ACT scores. Recall that these measures were multiplied by -1 so that students with high amounts of academic strain would have greater values on the ACT and HSGPA indicators. As a result, in this analysis, having a higher value on the ACT indicator actually reflects having a lower ACT score. The same relationship applies for HSGPA. In Model 2, both financial and academic objective role barriers, and intervention participation status accounted for about 7% of the variance in STEM research career plans. The change in variance (ΔR^2=.04) accounted for from Model 1 to Model 2 was marginally significant ($p<0.10$). This suggests that objective financial and academic role barriers had a marginal effect on STEM research career plans net of intervention participation.

Model 3 adds subjective financial and academic measures to the analysis. It includes financial stress as a measure of subjective financial role threats, as well as ability blame and academic discouragement as measures of subjective academic role threats. This model accounts for 9% of the variance in the outcome. While the model itself was significantly different from zero, the change in R^2 from Model 2 to Model 3 was non-significant which suggests that, on average, subjective elements of financial and academic role strain did not compound the negative effects of objective financial and academic strain.

Model 4 adds measures of students' multilevel strengths to the analyses. At the individual level, this includes a personal resiliency measure. At the community level, this model includes a extended family support measure. Model 4 provides insight concerning the relative effects of the intervention on STEM research career plans while also considering students' strains and strengths. The model accounts for 10% of the variance in STEM research career plans. The change in variance from Model 3 to Model 4 was non-significant. Overall, this suggests that the multilevel strength considered in the model did not help to better explain the outcome.

Models 5 and 6 include variables for students' background characteristics and major, respectively. This includes measures for students' gender, race/ethnicity and STEM major selection[11]. Model 5 accounts for 14% of the variance in students' STEM research career plans and the final model accounts for about 41% of the variance in the outcome. The change in R^2 from Model 4 to Model 5 was approximately .04 and significantly different from zero ($p<.05$).

---

[11] This study examines how indicators of intervention participation, student role strain, and multilevel strengths relate to students' advanced STEM career plans. Although the focus is not causality, it is helpful to note possible endogeneity issues related to STEM major and STEM research career plans. The hierarchical nature of the regression analysis in Table 4.5 allows the reader to examine the influence of intervention participation, student role strain and multilevel strengths on the outcome with and without consideration of STEM major choice.

Additionally, the change in R^2 from Model 5 to Model 6 was about .27 and significantly different from zero ($p<.001$)[12].

Pipeline Intervention Participation and Advanced STEM Career Plans. The information in Table 4.5 highlights the relative effects of pipeline interventions on students' advanced STEM career plans when student financial and academic role strain, multilevel strengths and other important background characteristics are considered. In general, the relative effects of the interventions on the outcome remained consistent when student role strain and multilevel strengths were considered. However, these effects were non-significant after accounting for various background characteristics.

In Models 1-4, participation in CIC SROP had a significant positive influence on STEM research career plans. Specifically, Model 1 suggested that CIC SROP participants had plans that were 0.44 standard deviations higher than their peers who did not have a summer research experience. Once role strain and strengths were accounted for in Models 2-4, the magnitude of the relationship increased and remained relatively stable across the subsequent models; however, the relationship with CIC SROP and the outcome was no longer significant when background characteristics were included in Model 5. This non-significant relationship remained in Model 6.

Other summer research opportunity program experience also positively influenced students' STEM research career plans, although this relationship was marginal. In Model 1, there was no significant relationship between OSROP and the outcome; however, the data suggested a non-significant trend in the predicted direction. In Models 2-4, the relationship between OSROP

[12] In addition to the hierarchical analysis outlined, a series of F-tests were conducted on the full model to determine if including the block of constructs for Models 1-6 resulted in a significant change in R^2 after account for all other factors. These results suggested that only the background measures and major made a significant contribution to the amount of variance explained in the outcome after including all constructs and measures in the analyses.

participation and the outcome was positive with marginal significance. In Model 2, while CIC SROP participants had STEM research career plans that were .48 standard deviations higher than their peers without research experience, OSROP students indicated STEM research career plans that were about .34 standard deviations higher than the comparison group. The magnitude of the relationship between OSROP participation and the outcome remained relatively constant once subjective role threats and multilevel strengths were also considered. As with CIC SROP, the relationship between OSROP participation and the outcome was non-significant once students' background characteristics were taken into account. This non-significant relationship remained in Model 6 when major was also considered.

Student Role Strain and Advanced STEM Career Plans. The results in Table 4.5 also indicated that objective and subjective financial and academic role strain negatively influenced STEM research career plans. These relationships manifested even after accounting for summer research program participation. However, these relationships changed once other important factors were considered.

In Model 2, a number of the objective financial and academic role strain measures did not relate to the outcome at a statistically significant level. However, the results suggested that students who received a means driven financial award (i.e. Pell Grant and/or college work study) had STEM research career plans that were .28 standard deviations below those of students who did not receive these awards ($p<.10$). Also, with regard to objective academic role strain, a lower ACT score was negatively related to the outcome. More specifically, controlling for intervention participation and other objective strains, each standard deviation increase in the ACT measure was affiliated with a .14 standard deviation decrease in STEM research career plans ($p<.10$). Because ACT is reverse coded, this suggested that as students' ACT scores decreased, so did their plans for pursuing STEM research careers. The influence of ACT score on the outcome remained significant but decreased slightly once subjective financial and academic role strains were accounted for in the analyses. However, the influence of ACT score on the outcome increased slightly in Model 4 when students' multilevel strengths were added to the analyses. The influence of ACT on the outcome was not significant in Models 5 and 6 which include students' background characteristics and major.

Model 3 suggested that, after accounting for intervention participation and objective financial and academic barriers, students' subjective threats did not have a significant effect on STEM research career plans. However, financial stress and academic discouragement were significantly related to the outcome after accounting for students' multilevel strengths. Model 4 suggested that, after considering intervention participation, objective barriers and strengths, for each standard deviation increase in financial stress, students' STEM research career plans decreased by .12 standard deviations. Also, for each standard deviation increase in academic discouragement, on average, students' STEM research career plans increased by .13 standard deviations. None of the student role strain measures were significantly related to the outcome after considering students' background characteristics or major.

Multilevel Strengths and Advanced STEM Career Plans. As noted, Models 1-4 indicated that objective role barriers and subjective threats can influence students' STEM research career plans. In addition, the results suggested that multilevel strengths were not significantly related to the outcome. More specifically, Model 4 indicated that neither personal resiliency nor extended family support had a significant influence on students' STEM research career plans. This non-significant relationship also existed in Models 5 and 6.

Background Characteristics, Major and Advanced STEM Career Plans. Models 5 and 6 provided some insight about how plans to pursue STEM research career differed according to students' background characteristics and major. The results suggested that, after accounting for intervention participation, role strain and multilevel strengths, males had higher STEM research career plans than females by .40 standard deviations ($p<.01$). When students' major was also considered, the relationship between gender and the outcome was reduced. Additionally, all else being equal, STEM majors had higher STEM research career plans than non STEM majors by 1.15 standard deviations ($p<.001$). However, there was no evidence of differences in this outcome between traditionally underrepresented students of color and their White and Other peers once these other important factors were considered.

Table 4.5.

Hierarchical Regression Analysis Assessing the Influence of Intervention Participation, Strains and Strengths on Advanced STEM Career Plans (a) (n=398)

	Models					
Independent Variables	Model 1: Intervention	Model 2: Fin & Acad Barriers	Model 3: Fin & Acad Threats	Model 4: Multilevel Strengths	Model 5: Selected Background	Model 6: Major
Intervention						
CIC-SROP	0.435 *	0.478 **	0.481 **	0.484 **	0.432	0.165
OSROP	0.325	0.342 ~	0.345 ~	0.334 ~	0.278	0.044
Objective Fin & Acad Barriers						
Used Public Assistance		0.071	0.077	0.071	0.072	0.072
Awarded Pell and/or college work study		-0.280 ~	-0.224	-0.232	-0.198	-0.102
Lower High school GPA (a) (b)		0.066	0.099	0.101	0.078	0.025
Lower ACT score (a) (b)		-0.135 ~	-0.123 ~	-0.132 ~	-0.109	-0.029
Subjective Fin & Acad Threats						
Financial Stress (a)			-0.118	-0.122 ~	-0.101	-0.052
Ability Blame (a)			0.059	0.071	0.074	0.057
Academic Discouragement (a)			0.094	0.130 ~	0.123	0.021
Multilevel Strengths						
Personal Resiliency (John Henryism) (a)				0.119	0.106	0.060
Extended Family Support (a)				-0.031	-0.031	-0.032
Background						
Male					0.402 **	0.268 *
Underrepresented Minority					-0.139	-0.113
Major						
STEM Major						1.153 ***
Constant	-0.295 *	-0.184	-0.222	-0.211	-0.223	-0.802 ***
R^2	0.031 *	0.069 *	0.092 *	0.103 *	0.140 **	0.407 ***
Change in R^2		0.038 ~	0.023	0.011	0.037 *	0.266 ***

~ p<.10; * p<.05; ** p<.01; *** p<.001

(a) Variables are z-scores (M=0; SD=1); (b) Reverse coded to represent strain; Unstandardized coefficients reported

Component 4: Moderating and Buffering Effects of Pipeline Interventions and Multilevel Strengths

Research Question 5: Do exemplary pipeline interventions moderate the relationship between objective and subjective student role strain and students' advanced STEM career plans? Moderated regression with interaction terms was conducted to investigate whether exemplary pipeline interventions moderate the relationship between student role strain and advanced STEM career plans. CIC SROP and OSROP participants were compared to No SROP students. Because of the limited sample size, moderating relationships were examined specifically for financial and academic strains that were shown to be significantly related to the outcome in the previous research question. The results of these analyses are included in Table 4.6[13]. The change in variance in STEM research career plans accounted for from Model 1 to Model 2 was not significant. Therefore, the moderated regression results suggested no statistically significant differences between the relationships of student role strain and the outcome by intervention setting.

[13] As previously noted, this study does not focus on causal relationships. However, it was helpful to acknowledge possible endogeneity issues related to STEM major and STEM research career plans. A supplemental examination of moderating relationships while excluding the indicator for major choice is included in Appendix H. Aligned with the findings in Table 4.6, this complementary analysis suggested that intervention participation does not moderate the relationship between student role strain and the outcome. However, as with Table 4.6, exploratory findings suggested a possible need to further investigate how the relationship between financial student role strain and the outcome may differ according to intervention experience.

Table 4.6.

Hierarchical Regression Analysis Assessing the Moderating Effects of Intervention Participation on Advanced STEM Career Plans (a) by Student Role Strain (n=398)

	Models			
Independent Variables	Model 1: Student Role Strain & Background		Model 2: Interactions	
Intervention				
CIC-SROP	0.157		0.592	*
OSROP	0.048		0.368	
Objective Fin & Acad Role Barriers				
Used Public Assistance	0.078		0.064	
Awarded Pell and/or College Work Study	-0.095		0.397	
Low High school GPA (a) (b)	0.024		0.018	
Low ACT score (a) (b)	-0.025		-0.012	
Subjective Fin & Acad Role Threats				
Financial Stress (a)	-0.048		-0.201	
Ability Blame (a)	0.053		0.063	
Academic Discouragement (a)	0.002		0.113	
Background				
Male	0.275	*	0.282	*
Underrepresented Minority	-0.109		-0.114	
Major				
STEM Major	1.162	***	1.146	***
Interactions				
Pell/WS x CIC SROP			-0.706	*
ACT x CIC SROP			0.01	
Financial Stress x CIC SROP			0.24	
Academic Discouragement x CIC SROP			-0.182	
Pell/WS x OSROP			-0.552	
ACT x OSROP			-0.077	
Financial Stress x OSROP			0.19	
Academic Discouragement x OSROP			-0.108	
Constant	-0.818	***	-1.134	***
R^2	0.404	***	0.426	***
Change in R^2			0.023	

~ p<.10; * p<.05; ** p<.01; *** p<.001; Unstandardized coefficients reported

(a) Variables are z-scores (M=0; SD=1)

(b) Reverse coded to represent strain

Although the differences between subgroups did not reach an adequate level of significance, a number of complementary analyses were conducted for exploratory purposes. While there was no evidence of moderating effects in Table 4.6 as indicated, a significant interaction between objective financial student role strain (i.e. Pell and/or college work study) and CIC SROP participation emerged. This interaction is graphed in Figure 4.1 to illustrate this exploratory relationship. This figure indicates that the negative relationship between objective financial role stain and the outcome exists for students that participated in CIC SROP, but the opposite relationship emerged for students with no intervention experience.

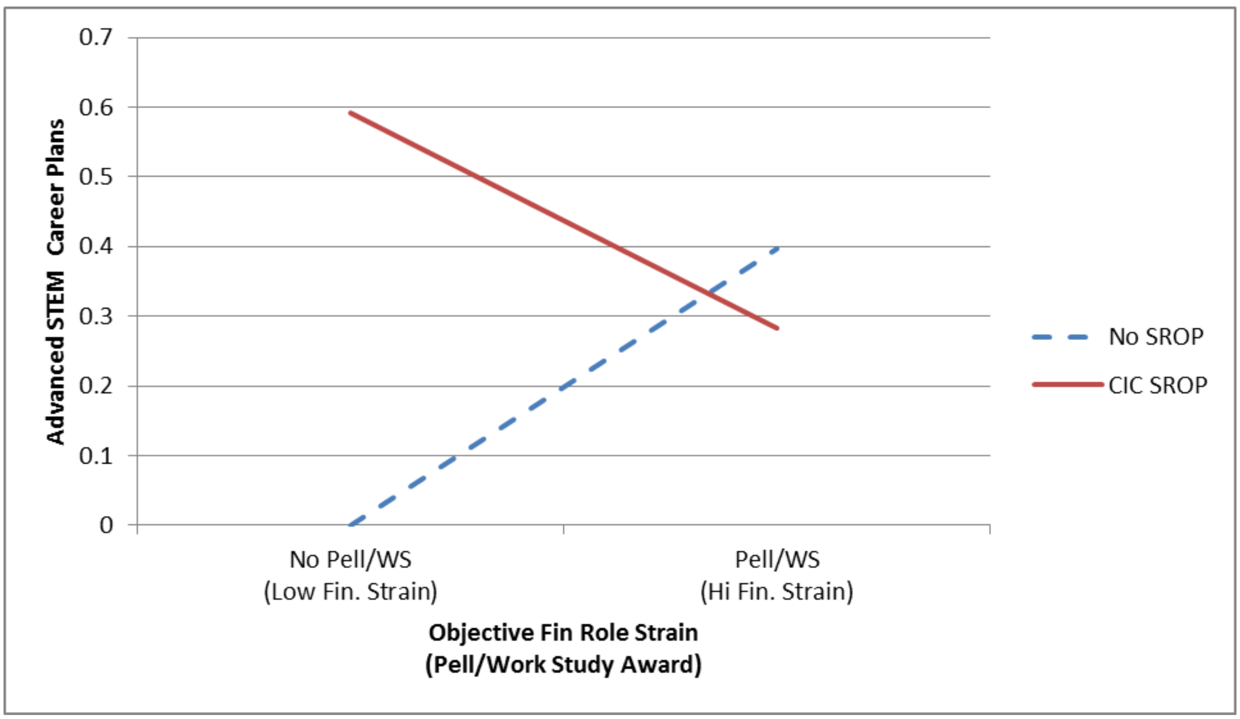


Figure 4.1. Exploratory Moderating Effect of CIC SROP participation on Objective Financial Student Role Strain

Also with regards to exploratory findings, subgroup analyses were conducted as a step towards further understanding emerging patterns in the data and future theory development (Bloom & Michalopoulus, 2013). These results provide useful insight about improving outcomes for students who do and do not have intervention experiences. The relationships examined in these exploratory analyses should be investigated in future research which uses a larger sample and has more statistical power.

The following subsections discuss outcomes for particular intervention subgroups—CIC SROP, OSROP and No SROP. Each subsection begins with an overall discussion concerning how well the models in the hierarchical regression help to explain variance in STEM research career plans for students who had particular intervention experiences. Also, each section highlights the relationships between measures of interest and the outcome within an intervention subgroup. Although there was no evidence that the relationships between financial and academic student role strain and advanced STEM career plans for students with and without intervention experiences differed, these subgroup analyses provide insight concerning how objective barriers and subjective threats influence STEM research career plans for students with similar intervention experiences. The results for the subgroup analyses are included in Tables 4.7-4.9[14].

Subgroup Analysis of CIC SROP Participants. For CIC SROP participants, the models which include objective and subjective student role strain, as well as background characteristics (i.e. Models 1-3) did not explain a statistically significant amount of variance in STEM research career plans. However, Model 4 which includes objective and subjective financial and academic

[14] In addition to the hierarchical analysis outlined, a series of F-tests were conducted for each of the subgroups to determine if the block of constructs within each of the models resulted in a significant change in R^2 after accounting for other factors. These results suggested that only the background measures made a significant contribution to the amount of variance explained in the outcome after including measures for financial and academic student role strain.

strain, background characteristics, and major accounts for 47% of the variance in the outcome ($p<.001$).

With regards to the influence of financial and academic student role strain on STEM research career plans, exploratory evidence suggested that objective financial barriers are negatively related to the outcome among CIC SROP participants. However, this relationship was not significant after accounting for background characteristics. More specifically, students that received Pell and/or college work study awards indicated plans that were about .41 standard deviations below their peers who did not receive such awards ($p<.10$). This negative relationship between Pell and/or college work study and STEM research career plans existed among CIC SROP participants even when accounting for subjective role strain indicators (i.e. Table 4.7, Model 2). Furthermore, the magnitude of this relationship remained relatively stable. For CIC SROP participants, the relationship between Pell and/or work study award and STEM research career was no longer statistically significant after accounting for background characteristics. No other objective or subjective role strain coefficients reached an appropriate level of significance for this subgroup.

In terms of background characteristics, Model 3 for the CIC SROP subgroup suggested gender differences in STEM research career plans among these students. On average, males had STEM research career plans that were .42 standard deviations higher than females ($p<.10$). This relationship was no longer significant in Model 4 which includes an indicator for STEM major. Also in Model 4, students that majored in a STEM field had plans that were higher than their non STEM peers. In fact, STEM majors had STEM research career plans that were 1.361 standard deviations above their non STEM major colleagues ($p<.001$).

Table 4.7

Subgroup Hierarchical Regression Analysis Assessing the Influence of Strains and Strengths on Advanced STEM Career Plans (a)—CIC SROP (n=196)

Independent Variables	Model 1: Fin & Acad Barriers	Model 2: Fin & Acad Threats	Model 3: Selected Background	Model 4: Major
Objective Fin & Acad Role Barriers				
Used Public Assistance	-0.124	-0.108	-0.132	-0.240
Awarded Pell and/or college work study	-0.405 ~	-0.412 ~	-0.371	-0.089
Low High school GPA (a) (b)	0.095	0.128	0.096	0.076
Low ACT score (a) (b)	-0.121	-0.139	-0.113	0.037
Subjective Fin & Acad Role Threats				
Financial Stress (a)		-0.015	0.004	0.049
Ability Blame (a)		0.054	0.077	0.071
Academic Discouragement (a)		0.080	0.083	-0.088
Background				
Male			0.416 ~	0.217
Underrepresented Minority			-0.080	-0.102
Major				
STEM Major				1.361 ***
Constant	0.467 **	0.467 **	0.358	-0.645 **
R^2	0.072	0.083	0.123	0.467 ***
Change in R^2		0.011	0.040	0.344 ***

~ p<.10; * p<.05; ** p<.01; *** p<.001
(a) Variables are z-scores (M=0; SD=1); (b) Reverse coded to represent strain; The outcome variable is also standardized
Unstandardized coefficients reported

Subgroup Analysis of OSROP Participants. As with CIC SROP, objective and subjective student role strain did not explain a significant amount of variance in STEM research career plans for OSROP participants[15]. However, Model 3 which includes objective and subjective financial and academic strain, as well as background characteristics, accounts for 31% of the variance in STEM research career plans (p<.05). Among OSROP students, objective academic strain was negatively related to STEM research career plans. In general, for each standard deviation increase in the ACT measure, students' plans to pursue a research career in STEM decreased by about .30 standard deviations (p<.05). The relationship remained even after

[15] Table 4.8, Model 1 for OSROP participants suggested that objective financial and academic barriers help to explain variance in STEM research career plans marginally. However, Model 2 lost explanatory significance with the addition of subjective threats. Future research should explore these relationships further to better understand why Model 1 is significant and Model 2 is not.

accounting for students' subjective threats and background characteristics. Furthermore, when students' major was also considered, a marginally significant and negative relationship between the ACT measure and STEM research career plans remained.

While objective academic strains remain a barrier for OSROP participants, the exploratory findings suggested that objective financial strain may not negatively impact OSROP students' STEM research career plans. More specifically, among OSROP students, students from families with limited financial resources had higher plans than those from families with higher incomes. As shown in Model 1 of Table 4.8, OSROP students from families that used some form of public assistance reported STEM research career plans that were .66 standard deviations above students from families without public assistance ($p<.05$). The magnitude of this relationship remained relatively consistent after subjective role threats and select background characteristics were considered. Furthermore, after also controlling for major, students' from families that used some form of public assistance had STEM research career plans that were about .46 standard deviations higher that their peers whose families had not used public assistance ($p<.10$).

In terms of the background measures, among OSROP students, males had higher STEM research career plans than females. More specifically, on average, males had plans that were .76 standard deviations higher than females ($p<.05$). The influence of gender on the outcome was reduced once major was considered, but remained significant. Also, on average, STEM majors had plans that were 1.22 standard deviations higher than non STEM majors ($p<.001$).

Table 4.8

Subgroup Hierarchical Regression Analysis Assessing the Influence of Strains and Strengths on Advanced STEM Career Plans (a)—OSROP (n=92)

Independent Variables	Model 1: Fin & Acad Barriers	Model 2: Fin & Acad Threats	Model 3: Selected Background	Model 4: Major
Objective Fin & Acad Role Barriers				
Used Public Assistance	0.659 *	0.650 *	0.653 *	0.460 ~
Awarded Pell and/or college work study	-0.139	-0.023	-0.083	0.059
Low High school GPA (a) (b)	0.175	0.203	0.118	-0.051
Low ACT score (a) (b)	-0.298 *	-0.294 *	-0.323 *	-0.216 ~
Subjective Fin & Acad Role Threats				
Financial Stress (a)		-0.124	0.023	0.079
Ability Blame (a)		0.115	0.154	0.149
Academic Discouragement (a)		-0.068	-0.040	-0.053
Background				
Male			0.756 *	0.610 *
Underrepresented Minority			0.233	0.156
Major				
STEM Major				1.216 ***
Constant	-0.140	-0.214	-0.561 ~	-1.326 ***
R^2	0.161 ~	0.194	0.309 *	0.550 ***
Change in R^2		0.033	0.115 *	0.241 ***

~ p<.10; * p<.05; ** p<.01; *** p<.001
(a) Variables are z-scores (M=0; SD=1); (b) Reverse coded to represent strain; The outcome variable is also standardized
Unstandardized coefficients reported

Subgroup Analysis of No SROP Students. For No SROP students, the models which include objective and subjective student role strain, as well as background characteristics (i.e. Models 1-3) did not explain a significant amount of variance in STEM research career plans. However, Model 4 which includes objective and subjective financial and academic strain, background characteristics, and major accounts for 31% of the variance in the outcome (p<.10).

Exploratory findings suggested that no coefficients for objective student role strain reached an appropriate level of significance. In terms of subjective academic threats, for each standard deviation increase in academic discouragement, students' STEM research career plans increased by .27 standard deviations. This relationship remained consistent once select background characteristics were considered, but it was non-significant after accounting for major.

There were no gender or racial/ethnic differences in the outcome among No SROP students. However, there was a difference with respect to major. On average, among No SROP students, STEM majors indicated STEM research career plans that were .77 standard deviations higher than non STEM majors (p<.01).

Table 4.9

Subgroup Hierarchical Regression Analysis Assessing the Influence of Strains and Strengths on Advanced STEM Career Plans (a)—No SROP (n=88)

Independent Variables	Model 1: Fin & Acad Barriers	Model 2: Fin & Acad Threats	Model 3: Selected Background	Model 4: Major
Objective Fin & Acad Role Barriers				
Used Public Assistance	-0.219	-0.149	-0.078	0.077
Awarded Pell and/or college work study	0.132	0.246	0.227	0.159
Low High school GPA (a) (b)	0.016	-0.002	-0.026	-0.012
Low ACT score (a) (b)	-0.138	-0.051	0.044	0.069
Subjective Fin & Acad Role Threats				
Financial Stress (a)		-0.206	-0.183	-0.133
Ability Blame (a)		0.054	0.013	-0.060
Academic Discouragement (a)		0.273 ~	0.258 ~	0.158
Background				
Male			-0.005	0.081
Underrepresented Minority			-0.413	-0.300
Major				
STEM Major				0.770 **
Constant	-0.287	-0.374	-0.134	-0.605 ~
R^2	0.024	0.142	0.176	0.313 ~
Change in R^2		0.118	0.035	0.137 **

~ p<.10; * p<.05; ** p<.01; *** p<.001
(a) Variables are z-scores (M=0; SD=1); (b) Reverse coded to represent strain; The outcome variable is also standardized
Unstandardized coefficients reported

Research Question 6: Is the relationship between student role strain and advanced STEM career plans buffered by multilevel strengths? This research question examines how students' cultural strengths may buffer the negative relationship between role strain and students' advanced STEM career plans. Because of sample size limitations, buffering was not considered for each of the role strain and multilevel strengths indicators. Instead, particular attention was given to the indicators that were statistically significant in the analyses of the overall sample (Table 4.5). The results for these analyses are included in Tables 4.10[16]. Complementary exploratory subgroup analyses of buffering effects are included in Appendix J.

The change in variance in STEM research career plans accounted for from Model 1 to Model 2 was not significant. Therefore, the moderated regression results suggested no statistically significant differences between the relationships of student role strain and the outcome by multilevel strengths. Although there was no evidence of buffering effects, the information in Table 4.10 suggests that the buffering effects of personal resiliency may be worth exploring further in the future. The exploratory findings suggest that the negative relationship between objective academic strain (e.g. Low ACT score) and STEM research career plans emerges only for those with lower levels of personal resiliency. For students with higher levels of personal resiliency, higher academic barriers are related to higher STEM research career plans. While these findings are exploratory, they suggest that resilience helps to buffer the negative influence of academic student role strain. These relationships should be explored further in future research and are illustrated in Figure 4.2.

---

[16] A supplemental examination of buffering relationships which excluded the indicator for major choice is included in Appendix I. Similar to the findings in Table 4.10, this complementary analysis suggested that students' strengths do not buffer the influence of student role strain on the outcome. However, unlike the findings in Table 4.10, no exploratory evidence of buffering emerged that was worth further investigation.

Table 4.10

Hierarchical Regression Analysis Assessing Whether Multilevel Strengths Buffer the Relationship between Student Role Strain and Advanced STEM Career Plans (a) (n=398)

Independent Variables	Models: Model 1: Student Role Strain, Multilevel Strengths & Background	Models: Model 2: Buffering Model
Intervention		
CIC-SROP	0.165	0.168
OSROP	0.044	0.089
Objective Fin & Acad Role Strain		
Used Public Assistance	0.072	0.067
Awarded Pell and/or college work study	-0.102	-0.102
High school GPA (a) (b)	0.025	0.017
ACT score (a) (b)	-0.029	-0.011
Subjective Fin & Acad Role Strain		
Financial Stress (a)	-0.052	-0.063
Ability Blame (a)	0.057	0.052
Academic Discouragement (a)	0.021	-0.009
Multilevel Strengths		
Personal Resiliency (John Henryism) (a)	0.060	-0.034
Extended Family Support (a)	-0.032	-0.047
Background		
Male	0.268 *	0.252 ~
Underrepresented Minority	-0.113	-0.111
Major		
STEM Major	1.153 ***	1.172 ***
Key Interactions		
Personal Resiliency x Pell/WS		0.143
Personal Resiliency x ACT		0.130 *
Personal Resiliency x Financial Stress		-0.033
Personal Resiliency x Acad. Discouragment		0.006
Extended Family Support x Pell/WS		0.023
Extended Family Support x ACT		0.070
Extended Family Support x Financial Stress		-0.003
Extended Family Support x Acad. Discouragement		0.013
Constant	-0.802 ***	-0.830 ***
R^2	0.407 ***	0.434 ***
Change in R^2		0.027

~ p<.10; * p<.05; ** p<.01; *** p<.001

(a) Variables are z-scores (M=0; SD=1);

(b) Reverse coded to represent strain;

Unstandardized coefficients reported

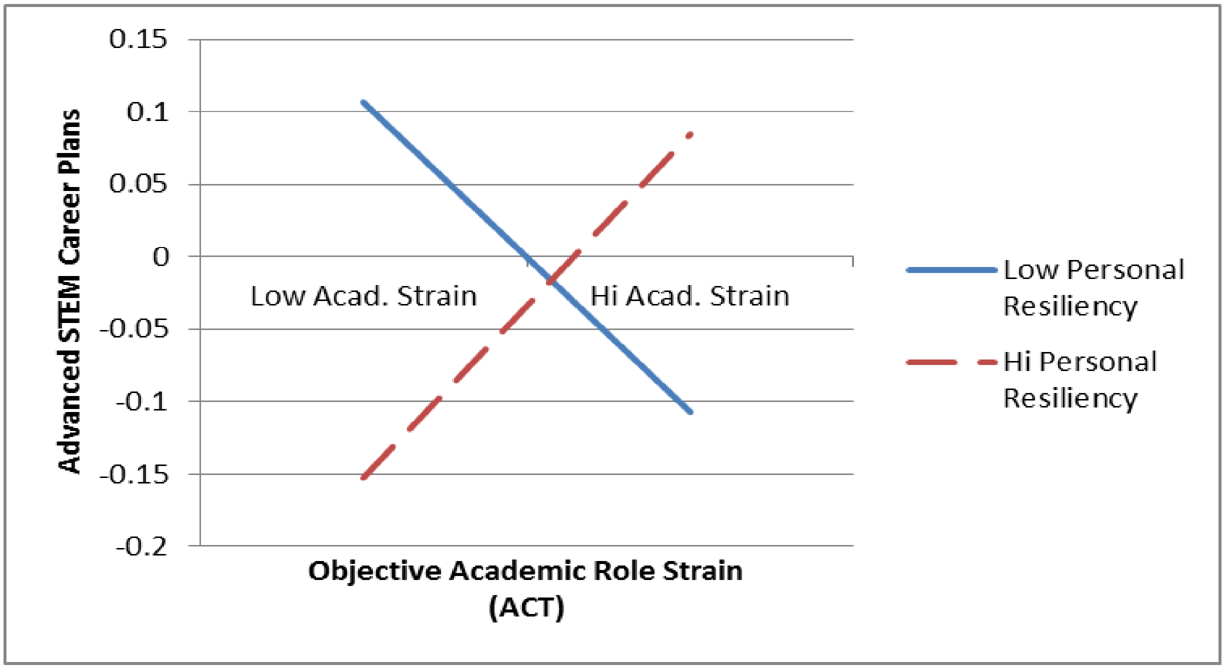


Figure 4.2. Exploratory Buffering Effect of Personal Resiliency on Objective Academic Student Role Strain

CHAPTER V

DISCUSSION

This theory-driven dissertation study makes unique contributions to the higher education pipeline intervention literature by further clarifying social psychological mechanisms through which financial and academic barriers impede successful STEM outcomes among underrepresented students within intervention settings. In general, guided by role strain and adaptation theory, this study found: (1) that financial and academic challenges (objective barriers and subjective threats) represent distinct dimensions of student role strain; (2) that intervention participation, financial/academic student role strain and cultural strengths combine to better explain successful STEM outcomes than intervention participation alone; and (3) both similarities and differences on major research variables by gender and racial/ethnic group status. This study employed a range of multivariate statistical approaches to investigate role strain and adaptation mechanisms through which exemplary summer research interventions can influence students' advanced STEM career plans.

This theory-driven study differs from traditional program evaluation research in that its primary objective is to better understand social psychological factors that can impede or enhance intervention participants' benefits, as opposed to a summative evaluation of overall intervention effects. With randomized experimental designs as the "gold standard," outcome evaluation studies examine the overall effects of an intervention, and ask, "Does it work?" (Cook & Campbell, 1979; Hoyle, Harris & Judd, 2002; Shadish, Cook & Campbell, 2002).   More theory-driven studies employ a range of different methods to better explain underlying mechanisms and ask, “How and why does it work?” (e.g. Donaldson, 2007; Mark, Donaldson & Campbell, 2011; Mark & Henry, 2004; Shadish, Cook & Leviton, 1991). Such a theory-driven approach provides a deeper understanding of how student role strain and adaptation mechanisms can influence intervention efficacy beyond the overall intervention effect. Furthermore, this more nuanced understanding of intervention outcomes has become a focal, policy-relevant issue for a number of national organizations including the National Institutes of Health, National Science Foundation and the American Association for the Advancement of Science.

As an initial step, this research first sought to conceptualize the strains with which many underrepresented students are confronted. In this study, underrepresented students are broadly defined as those who are from lower-income backgrounds and/or minority ethnic/racial groups. Accordingly, this study examined strains that are generally relevant for these students. Student financial role strain was important to acknowledge because many lower-income students have to overcome financial challenges in their pursuit of higher education (e.g. St. John, Fisher, Williams & Daun-Barnett, 2008; St. John, Musoba & Simmons, 2003; St. John, Musoba, Simmons & Chung, 2002; St. John, Musoba, Simmons, Chung, Schmit & Peng, 2004). Furthermore, academic student role strain was also important to note given that lower-income and minority students often encounter academic preparation barriers in K-12 which also impact their outcomes in higher education (e.g. National Research Council, 2011).

While many studies focus on the objective financial and academic barriers that students face, this research sought to better conceptualize student role strain in these dimensions by noting both the objective strains that students must overcome, as well as their subjective appraisals or responses to objective barriers.

In addition to student role strain, this study also acknowledges how students' strengths influence intervention outcomes. This research employed emic measures to conceptualize the multilevel strengths that students from underrepresented groups can draw from when faced with adversity. At the personal level, this included students' resiliency or ability to bounce back or thrive in the face of adversity (Bowman, 2013). This construct was operationalized using the John Henryism measure which was specifically developed to have particular relevance for underrepresented groups (James, Hartnett & Kalsbeek, 1983). From a community perspective, the role of family support was examined with an emphasis on support from various members in the family unit (i.e. nuclear family, blood kin and parakin). This construction of family is often embraced by students from underrepresented groups (e.g. Billingsley, 1992; Reyes, 2002).

After conceptualizing student role stain and multilevel strengths, racial and gender differences in these constructs were examined to provide insight about group differences. Next, this research examined the relative influence of intervention participation, student role strain and multilevel strengths on students' advanced STEM career plans. This aspect of the study sought to better understand how financial and academic student role strain and multilevel strengths influence intervention outcomes beyond the intervention experience.

This research also explored how (1) intervention experiences moderated the influence of strains on advanced STEM career plans, and (2) students' strengths buffered the influence of strains on the outcome. While there was no evidence of moderating effects, the experiences of students within particular intervention subgroups were also examined. From an exploratory perspective, the subgroup analyses provided useful information concerning how objective barriers, subjective threats and strengths relate to advanced STEM career plans for students who shared common intervention experiences. This information is important in order to begin to understand outcomes for students with varying experiences and to develop approaches for improving outcomes for students within these particular groups. In terms of buffering effects, there was no definitive evidence that students' strengths helped to buffer strain. However, exploratory findings regarding these relationships were discussed.

Based upon these findings, the following sections outline various implications from this study. This section begins with a discussion of the practical significance of the findings. Afterwards, the conceptual implications are discussed and an emerging conceptual framework for understanding intervention efficacy for underrepresented students is outlined. Finally, the study limitations and areas for future research are also examined.

Practical Significance

Understanding Intervention Outcomes.

Intervention Participation and Advanced STEM Career Plans. This research seeks to better understand the mechanisms by which exemplary pipeline interventions can promote advanced STEM career plans for students from underrepresented groups. The findings from these analyses suggest that summer research intervention participation can influence students' STEM research career plans, but the relationship may be largely driven by students' major choice and gender. The hierarchical regression analysis which used the overall sample (i.e. Table 4.5) suggested that both CIC SROP and OSROP participation were related to an increase in students' advanced STEM career plans. However, the influence of OSROPs on the outcome did not reach that of CIC SROP. One conceivable explanation for this disparity could be the degree of variation in program offerings and underlying objectives across these other interventions.

Unlike CIC SROP, the other research opportunity programs did not necessarily share a common objective, set of expectations and programmatic features.

As shown within these analyses, the positive relationship between CIC SROP or OSROP intervention participation and students' advanced STEM career plans was no longer significant once students' gender was considered. Also, accounting for students' major increases substantially the percentage of variance explained in the outcome. Given that there was a greater percentage of STEM majors and men within the intervention groups compared to the No SROP subgroup, perhaps the intervention participant selection process helps to explain the STEM-related outcome. Nonetheless, this finding underscores the need for interventions that: (1) focus on developing students' interest in the sciences at earlier points within their academic careers, and (2) targeting women, specifically.

Collegiate research interventions have expanded tremendously since the Boyer Commission Report (1998, 2002) which recommended that research become an integral part of undergraduate student training. This development inadvertently ended a longstanding debate about the dichotomy between teaching and research within the academy, and positioned research as a teaching tool (Bauer & Bennett, 2003). In addition to the summer research opportunity programs examined in this study, there has also been a proliferation in programs designed to involve students in research during the academic year. Many of these programs offer participants academic credit which further underscores the current integration of research into the undergraduate curriculum. Although other research suggests that these programs can promote positive outcomes (e.g. Bauer & Bennett, 2003; Hunter, Laursen & Seymour, 2006; Lopatto, 2004, 2007; Maton, Domingo, Stolle-McAllister, Zimmerman & Hrabowski, 2009; Pender, Marcotte, Domingo & Maton, 2010; Yauch , 2007), this study highlights the need for earlier interventions. Some studies suggests that many students who plan to pursue STEM careers develop these ambitions during their pre-college experiences (e.g. Hunter, Laursen & Seymour, 2006; Russell, Hancock & McCullough, 2007). Furthermore, other literature notes that the trajectory towards STEM majors and careers starts with the preparation that students receive before college (e.g. Crisp, Nora & Taggart, 2009; National Research Council, 2011). Because of this, a number of STEM programs have been developed to expose high school students to STEM research and to encourage them to pursue careers in these fields (e.g. Zhe, Doverspike, Zhao, Lam & Menzemer, 2010). This research supports the further development of these types of programs in order to encourage students to pursue STEM majors.

In addition to insights regarding major choice, this study also highlights the gender disparities in STEM that are often discussed in the literature (Blickenstaff, 2005; Brainard & Carlin, 1998; Cole & Espinoza, 2008; Hill, Corbett & St. Rose, 2010). According to these findings, gender issues in STEM on a broader level also have an effect on intervention outcomes. As noted, even after accounting for intervention participation and major, men had plans to pursue STEM research careers that were higher than their female colleagues. This suggests that gender bias in the STEM pipeline remains an issue despite efforts to provide students with the academic and other supports offered by summer research opportunity programs. Hence, the larger issues regarding gender in STEM fields have an influence on intervention outcomes over and beyond the actual intervention experiences. Additional study implications regarding gender are discussed in more detail in a following section. Overall, these findings suggest a need to address gender-related issues in interventions in order to improve advanced STEM career-related outcomes for women from underrepresented groups. Coupled with the findings concerning the need for earlier interventions, perhaps pre-college STEM interventions which specifically target girls and young women would help to diminish these gender disparities in STEM research career plans.

Moderated Relationships and Intervention Outcomes by Intervention Group. Recall that the moderated regression analyses indicated that intervention participation did not moderate the influence of financial and academic student role strain on students' advanced STEM career plans. Therefore, there is no evidence that these strains relate to students' outcome differently based on their intervention experiences. While the analysis of moderating relationships underscored this point, it is important to note that this study was conducted using a limited sample. Exploratory findings suggested that there may be differences in how objective financial student role strain relates to advanced STEM career plans by intervention participation (CIC SROP vs. No SROP) worthy of future investigation with a larger sample. Also, the subgroup analyses provided exploratory evidence about the relationships between strain and advanced STEM career plans for students with particular intervention experiences. These analyses provide some initial insights about how to promote better outcomes within each intervention subgroup. Future analyses should employ hierarchical linear modeling to investigate within group and between group effects as it relates to the influence of financial and academic student role strain on advanced STEM career plans. The following subsections provide a summative overview of the exploratory insights offered by these subgroup analyses.

CIC SROP Intervention Outcomes. The CIC SROP provides a number of supports to its participants including educational enrichment activities, exposure to research, formal and informal networking opportunities, and a stipend. Despite these resources, initial insights suggest that objective financial challenges may remain an issue for many program participants. The exploratory analysis of moderating effects (Figure 4.1) suggested that the negative relationship between objective financial strain (i.e. Pell and/or college work study) and advanced STEM career plans existed among CIC SROP participants, but not among student with no intervention experience. It is unclear why these relationships would differ for CIC SROP and No SROP students. Because CIC SROP is based at a number of top-ranked research institutions that have substantial tuition charges, perhaps students in these programs are more acutely aware of their financial strains[17].

The subgroup analysis provided further support that objective financial role strain was negatively related to advanced STEM career plans for CIC SROP students. Within CIC SROP, students with limited financial resources (i.e. Pell and/or college work study recipients) reported STEM research career plans that were lower than their peers who were more financially resourced. Furthermore, these differences were not simply a function of students' subjective appraisals of the objective financial barriers. However, the negative relationship between objective financial student role strain and advanced STEM career plans was no longer significant after accounting for background characteristics. Amongst the background characteristics, gender was significantly related to students' advanced STEM career plans. This indicator was no longer significant after accounting for students' major.

Supplemental correlation analyses indicated no significant relationship between the objective financial strain measure (i.e. Pell and/or college work study) and any of the student background indicators. However, both the strain measure and the gender variable were related to

[17] The CIC institutions are largely comprised of the Big 10 institutions, as well as the University of Chicago and Northwestern University. During the 2012-2013 academic year, the average undergraduate tuition at a Big 10 institution was approximately $12,000 for in-state residents and $28,000 for non-resident students for the academic year. The average graduate tuition was about $13,000 for in-state residents and $27,000 for non-residents (Purdue University Office of Budget and Fiscal Planning, 2012).

STEM major[18]. It follows that there may be some confounding relationships between these measures and the outcome worth exploring in future research regarding outcomes for CIC SROP participants. In keeping with the Barron and Kenny (1986) mediation test, STEM major may mediate the influence of gender on advanced STEM career plans. Correlation analyses indicated that there was generally a negative relationship between Pell and/or college work study Award and STEM major among CIC SROP participants. This suggests that, within this intervention group, lower-income students' reduced STEM research career plans may be related to challenges regarding their representation among STEM majors. A number of studies note that the academic exposure that students receive in K-12 is critical for preparing them to pursue STEM fields in college (e.g. Crisp, Nora & Taggart, 2009; National Research Council, 2011). Additionally, research underscores that many lower-income students are often concentrated in schools that are under-resourced (Lee & Burkham, 2002; Museus, Palmer, Davis & Maramba, 2011). Accordingly, the challenges that many lower-income students face with gaining access to proper academic resources can have a detrimental impact on their trajectory into STEM majors and STEM research careers. This highlights the need to address these early preparation issues among lower-income populations in order to promote better outcomes for these students in CIC SROP.

Additionally, lower-income students in CIC SROP may not pursue STEM majors because of financial reasons. Perhaps these students have financial responsibilities such as work obligations which make it difficult to balance the demands of a STEM major while meeting their other fiscal obligations. Accordingly, it is important to investigate how financial need may limit students' major choice selection process. Also, because STEM degrees can take longer to

[18] While the measure for objective financial role strain (i.e. Pell/work study) was not correlated with gender for CIC SROP students, objective financial strain and gender were correlated with STEM major. Also, STEM major was highly correlated with the outcome (r^2=.65, p<.001).

complete than other fields, perhaps lower-income students pursue other fields because of increased pressures to enter the labor market as quickly as possible. While the benefits to higher education cannot be reduced to economic returns (Hout, 2012), these exploratory findings may suggests a need to provide lower-income students in CIC SROP with additional financial support and useful information about how STEM degrees can contribute to their economic stability in the future.

OSROP Intervention Outcomes. Exploratory subgroup analyses suggest that OSROP participation may reduce or buffer the possible negative relationship between objective financial barriers and advanced STEM career plans. Within these other programs, many students with higher financial strain (i.e. those from families that received public assistance) indicated STEM research career plans that were above those of students who had greater financial resources, even after accounting for subjective strains, key background characteristics, and major. This suggests that perhaps OSROPs have successfully encouraged students to pursue STEM research careers despite economic challenges. Perhaps these programs offer financial support to students or they are closely aligned with broader university recruitment efforts that offer funding for graduate work. Further investigation would be needed to fully understand the relationship between objective financial strain and advanced STEM career plans for OSROPs students. This information could help to inform the future development of OSROPs and similar programs which seek to facilitate better outcomes for lower income students.

While initial insight suggested that OSROPs may help to reduce the negative relationship between financial barriers and advanced STEM research career plans, it appears that challenges facilitating successful outcomes for students with limited prior academic exposure and preparation remain. Among OSROP participants, on average, students with lower academic achievement in high school (i.e. ACT score) indicated lower plans to pursue STEM research careers. This suggests that prior academic barriers can have lasting effects on career plans in STEM. There are a number of possible explanations for this difference in outcome. First, given the relationship between research careers and graduate study, perhaps students with prior academic barriers are more discouraged about their ability to successfully pursue graduate work. It would follow that these students may also be less likely to plan to pursue STEM research careers that require graduate training. It is also possible that these students have reduced efficacy beliefs with regard to their ability to meet the demands of a research career because of the academic challenges that they have experienced in the past. To address these issues, it is important to connect students' research experiences to broader academic training that would be beneficial beyond the summer opportunity and prepare students for graduate study, specifically. Broader policy initiatives have promoted the use of research to supplement and enhance undergraduate training (Boyer Commission, 1998, 2002; Katkin, 2003). Program administrators should consider offering services to bolster students' academic preparation and successful navigation into and through graduate school. Among other things, this can include: (1) GRE preparation courses; (2) tutorial services; (3) study groups; and (4) peer academic mentoring programs. Administrators may also consider strategies for increasing students' efficacy beliefs with regards to their research ability.

No SROP Intervention Outcomes. The exploratory findings for No SROP students suggest that objective financial and academic student role strain were not related to advanced STEM career plans for these students. Also, background characteristics were not related to the outcome in this subgroup. However, among No SROP students, subjective academic role strain (i.e. academic discouragement) was positively related to STEM research career plans before controlling for students' major. This relationship was no longer significant after major was included in the analyses. Accordingly, preliminary findings suggest that students' major influenced the relationship between subjective strain and the outcome. In keeping with the Barron and Kenny (1986) mediation test, this suggests a possible intervening relationship. An examination of the correlation between academic discouragement and major suggests that STEM majors were generally more discouraged academically. The nature of the relationship merits further investigation. Given the challenges with pursuing a STEM field, perhaps majoring in STEM resulted in increased student discouragement. An alternate explanation for this finding relates to possible measurement issues. It is possible that the relationship between academic discouragement and STEM major manifested because the measure employed did not tap the construct adequately[19]. Future research should seek to better understand the academic discouragement measure used in these analyses, and how it relates to STEM major and STEM research career plans for students without intervention support.

The Role of Multilevel Strengths. The findings from the hierarchical regression analysis which included all intervention groups (Table 4.5) suggest that the student strengths considered in this study are not related to their STEM research career plans. Recall that neither the measure for personal resiliency nor extended family support was significantly related to the outcome. However, it is worth noting that adding those measures to the overall analyses helped to illuminate relationships that appeared to be suppressed when these measures were excluded. Specifically, after students' multilevel strengths were included in the analyses, some of the relationships between subjective threats and the outcome that were non-significant in previous

[19] Recall that the internal consistency for the academic discouragement measure suggested that the construct was tapped with a fair degree of reliability. Further psychometric analyses of the construct should be considered in future research.

models became significant (Table 4.5, Model 4). This highlights that recognizing students' strengths provides a better understanding of how their strains can relate to outcomes. Moreover, it suggests that the influence of those strains on outcomes cannot be fully explicated without also acknowledging the role of strengths at the personal and community level. Adding the multilevel strength measures to the model did not result in a significant change in the amount of variance explained in advanced STEM career plans. Therefore, these findings are not definitive. However, they do highlight research areas worth further investigation.

The buffering effects analysis provides additional insights concerning the relationship between personal strengths and advanced STEM career plans. Recall that the moderating regression analysis did not provide evidence that strengths buffered strains. Because the interaction model in Table 4.9 did not result in a significant change in the amount of outcome variance explained, it is generally not appropriate to interpret individual interaction terms that are significant (Jaccard & Turrisi, 2003). However, because this study has a limited sample size, it would be very difficult to find significant moderating effects. It is possible a similar analysis with a larger sample would illuminate different effects and this should be explored further in future research. Given these limitations, the significant interaction terms that emerged with this small sample may highlight relationships worthy of additional research.

The exploratory findings indicate that personal resiliency may buffer the negative relationship between objective academic student role strain and the outcome. The negative relationship between objective academic student role strain and advanced STEM career plans manifested only for students with low personal resiliency (Figure 4.2). This evidence suggests that personal strengths may serve as a protective factor and reduce the negative influence of objective academic student role strain for students from underrepresented groups. Overall, the findings concerning multilevel strengths suggest that accounting for these characteristics may provide useful insights about how objective strain influences advanced STEM career plans.

Theoretical and Conceptual Implications

Guided by role strain and adaptation theory, this study helps to better clarify the objective role barriers, related subjective appraisals of those barriers, and cultural strengths that underrepresented students bring to intervention settings (Bowman, 2006; 2011; 2013). In addition to information about the social psychological mechanisms by which interventions operate, the results from this study also provided useful conceptual insight about students' objective barriers and subjective threats within financial and academic domains. Furthermore, this study also provided insight about students' multilevel cultural strengths – extended family support and personal resiliency. Although the relative effects of the measures for objective and subjective role strain and multilevel strengths were often non-significant in these analyses after accounting for other important factors (i.e. background characteristics and major), the conceptual insights gained about these constructs merit attention. Consistent with the basic role strain and adaptation model, the emerging patterns in this study suggest that students' strains and strengths may operate as pivotal mediators of the relationship between background factors and long-term STEM research career plans (e.g. Bowman, 2011; 2013). Related theoretical and conceptual issues are discussed in more detail in this section.

Understanding Objective Barrier and Subjective Threats in Policy Research. While Pell and college work study awards were designed and implemented to expand college opportunities for students from lower-income families, it is important to remember that these awards are means-driven. This distinction is obvious, but critical because it requires us to acknowledge the general financial strain that students who are eligible for these awards must overcome. In that way, although these types of awards can expand college opportunities (Dynarski, 2003; Dynarski & Scott-Clayton, 2013; St. John, 2004), eligibility for such awards indicates a broader economic challenge at the family level. This interpretation is supported by these analyses in that Pell and/or college work study awards were highly related to the family's use of public assistance during periods of economic hardship. Eligibility for these types of awards indicates that students have encountered some form of objective financial role strain that should generally be acknowledged in intervention settings.

Although interventions and policies can be implemented to help alleviate the financial issues that students experience while in college, it is important to understand that these policies and initiatives cannot fully dissolve the strain that manifests when students come from economically challenged *families*. Eliminating this strain would require an approach that seeks to improve structural and systematic barriers to economic advancement within the family unit—an approach beyond the scope of most universities to date. While higher education institutions have not considered such all-encompassing methods for addressing financial challenges, there have been emerging efforts within the United States and globally to improve student outcomes in a holistic manner which also addresses family and broader community challenges.

With regard to academic challenges, a number of studies examine how high school grade point average and ACT/SAT score relate to college outcomes (e.g., Adelman, 1999, 2006; DeBerard, Spielmans & Julka, 2004; DesJardins, McCall, Ahlburg, & Moye, 2002; DesJardins & Lindsay, 2008; Hearn, 1988; Horn & Kojaku, 2001; Horn & Nunez, 2000; Rose & Betts, 2001; St. John, 1991), and there is evidence of a positive relationship between these factors and college success. However, existing literature has not examined these factors within a student role strain framework. Accordingly, the emphasis in the literature has not been on how increases in academic strain correspond to *decreases* in college success. The reverse coding for ACT score and high school grade point average employed in these analyses allowed these imbedded relationships to be discussed more directly. Also, the correlation analysis suggests that these items may represent an underlying latent construct (i.e. objective academic role strain), although they have traditionally been treated as individual achievement measures.

In addition to examining objective financial and academic strains conceptually, this study also suggests that both objective barriers and subjective threats are important to consider with regard to students' career plans in STEM areas. Most policy research has focused primarily on the relationship between objective strains and college success. The literature indicates clearly that the objective financial and academic strains that students experience in college can have a detrimental impact on their success (e.g., Adelman, 1999, 2006; Braunstein, McGrath & Pescatrice, 1999; Horn & Kojaku, 2001; Millet, 2003; Paulsen & St. John, 2002; Perna, 2000; St. John, Paulsen & Starkey, 1996). This study investigated the influence that these objective challenges can have on college outcomes, but it also acknowledged students' cognitive responses to objective barriers. Recall that both objective and subjective role strain emerged as independent latent constructs within the analyses. Accordingly, these results suggest that students' cognitive appraisal of objective barriers are distinct from the *actual* objective barriers. While objective barriers are important factors to consider in policy research, it is also important to note that individuals can respond to those barriers in ways that promote adaptive or risky behavior. These subjective responses are distinct from the objective barriers themselves. This research used the Bowman Role Strain and Adaptation Framework to emphasize these distinctions. As shown in the various analyses presented, both objective barriers and subjective threats were related to the outcome. Therefore, the evidence supported the existence of objective student role barriers, as well as related subjective student role threats.

Multilevel Strengths and the Use of Culturally Relevant Measures. As previously noted, these analyses illustrate that it is important to consider the strains and strengths that underrepresented students bring to an intervention in order to fully understand how such experiences influence research career plans in STEM fields. The findings discussed previously suggested that a better understanding of intervention effects and strain—objective or subjective—may be possible once students' strengths are considered. Also, exploratory findings suggest that personal strengths may help to buffer some strain.

The evidence presented in this study provided support for the use of culturally relevant measures for students' multilevel strengths. I used the John Henryism and extended family support scales to create emic measures for personal resiliency and family support, respectively. The psychometric analysis suggested that these measures were represented with high levels of internal consistency in this sample and their inclusion in these analyses provided deeper insight about how other important factors influence intervention outcomes. The value of using emic measures is important to highlight given ongoing discussions among scholars about the use of mainstream theories and frameworks to understand the experiences of traditionally underserved populations (Stage & Wells, in press). While etic measures may provide useful insights about the experiences of underrepresented students, they do not fully acknowledge the non-normative challenges that play a critical role in understanding how these students navigate the college experience.

Emerging Conceptual Relationships

Gender and Student Role Strain. The findings for this study suggested that there may be strains due to gender which negatively impact intervention outcomes. These findings reflected broader issues regarding the need to increase the pipeline of women in STEM professions. The descriptive results indicated that, on average, the women in this study had lower STEM research career plans than men. This finding is aligned with other research that discusses the underrepresentation of women in many STEM fields and notes that a number of environmental factors deter women from pursuing STEM majors and careers including gender bias within these subject areas; stereotypes concerning women in the sciences; and misconceptions about competence (e.g. Blickenstaff, 2005; Brainard & Carlin, 1998; Hill, Corbett & St. Rose, 2010). The multivariate results provided further evidence of this relationship even after accounting for intervention experiences, financial and academic student role strain, multilevel strengths and STEM major choice. Given the gender disparities in STEM research career plans, the findings suggested that women encountered a particular strain when pursuing advanced STEM career plans. As previously noted, gender bias and female discouragement in STEM start at very early stages in women's educational careers (Hill, Corbett & St. Rose, 2010). The early discouragement that women experience in education could help to explain the differences in outcomes that manifest in higher education. Also, other research notes that women who are resilient against the gender biases and science and mathematics stereotypes prevalent in K-12, still have additional hurdles to overcome in higher education (e.g. Brainard & Carlin, 1998). Accordingly, future research could further explore the gender strain concept with regards to STEM research career plans. Also, it is important that interventions recognize gender issues in the broader definition of what it means to be "underrepresented." Interventions should pay particular attention to approaches and programmatic developments that address strains related to gender in STEM fields and professions. This is especially critical in fields such as engineering, physics, and computer science which continue to be male-dominated. Future research should examine gender differences in intervention outcomes to further investigate if these summer research opportunities are helping to close the STEM gap between men and women.

This study also suggested that gender disparities exist in terms of subjective financial role strain. On average, women had higher levels of financial stress—an issue that has been shown to hinder positive college outcomes within the broader literature (e.g. Advisory Committee on Financial Aid, 2010; Brazziel & Brazziel, 2011; Cabrera, Castaneda, Nora & Hengstler, 1992; St. John, Paulsen & Starkey, 1996). It is important to note that, in this study, high percentages of men and women were subject to the objective financial barriers. For example, 55 percent of males and 63 percent of females received Pell and/or College Work study awards[20]. It is unclear why women experienced a more negative cognitive response to financial barriers. However, as previously noted, this underscores the importance of recognizing students' actual barriers and their subjective reactions to such barriers. Future studies should further investigate differences in perceived financial challenges by gender. A number of studies within the financial aid literature note that subjective financial challenges can deter positive outcomes in college (e.g. Advisory Committee on Financial Aid, 2010; Brazziel & Brazziel, 2011; Cabrera, Castaneda, Nora & Hengstler, 1992; St. John, Paulsen & Starkey, 1996). Because the women in this study appear to be disproportionately burdened with these challenges compared to men, it is important to gain a better understanding of why these relationships emerged within the sample.

[20] There was no statistically significant difference in the percentage of males and females that received these awards.

From a practical perspective, these theoretical insights suggest that interventions should be attentive to strain that is unique to women's experiences and how subjective financial threats may differ by gender. Possible approaches for addressing these challenges include the creation of academic spaces that resist negative environmental influences, and combat misconceptions about (1) women's academic abilities and (2) gender-oriented major "fit." Furthermore, intervention administrators should seek to better understand other issues such as financial difficulties which may disproportionately impact certain students.

Race/Ethnicity and Student Role Strain. The descriptive results also suggested that students of color generally experienced a particular strain with regards to advanced STEM career plans. Generally, these students had lower STEM research career plans than their White and Other peers. Other research has noted these disparities and the need to increase the pipeline to STEM professions for underrepresented students of color (e.g. National Research Council, 2011). In an effort to increase the supply of STEM professionals within the United States, some scholars have acknowledged the historic underrepresentation of certain groups in these fields and the need to increase the number of underrepresented students who pursue STEM majors as a strategic step towards the larger agenda to bolster the country's STEM workforce (National Research Council, 2011). This is becoming increasingly critical given demographic shifts and projections which suggest that underrepresented students of color who are not well represented in STEM are increasingly becoming a large share of the overall population. Accordingly, it is important that research seeks to better understand strains that can afflict particular racial groups and could deter students' STEM-related outcomes.

Despite the descriptive findings, the multivariate analysis indicated that, amongst the students within this study, there was no statistically significant difference in advanced STEM career plans between students of color and their White and Other peers after accounting for financial and academic student role strain, multilevel strengths and other important factors. Because a large percentage of the students in this study are underrepresented in some capacity (i.e. underrepresented students of color, lower-income, first-generation college attendants, etc.), perhaps many of them share similar challenges navigating through higher education and, thus, the racial/ethnic differences that are generally discussed in the literature do not manifest within this sample. Accordingly, these findings suggest that it is important to consider students' strains, strengths, and relevant academic experiences in order to fully understand racial/ethnic differences in STEM-related outcomes.

In addition to differences in STEM research career plans, a higher percentage of students of color also suffered from higher levels of objective financial student role strain. Compared to Whites and Others, a higher percentage of students of color were awarded Pell and/or college work study, and came from families that used public assistance. Given the relationship between financial challenges and successful college outcomes in general (Braunstein, McGrath & Pescatrice, 1999; Hearn, 1988; Rose & Betts, 2001; St. John, 1991; St. John, Musoba, Simmons, & Chung, 2002), it is important that program administrators and other constituents are aware of these issues within the context of interventions and how they may impact outcomes—particularly for students of color. Furthermore, as previously mentioned, strategies to reduce these financial barriers at earlier points along the education continuum may also help to increase STEM-related career outcomes by expanding the pool of STEM majors. This is especially important given the push to increase the racial/ethnic diversity of STEM professionals. While students of color experienced higher levels of objective strain, their cognitive appraisals of those strains were similar to Whites and Others. This also underscores the importance of distinguishing the objective strain from students' perceptions about barriers.

With regard to objective academic barriers, across the overall sample, the average ACT score and HSGPA indicated that the students in the study had a high degree of academic preparation and exposure, generally. However, on average, students of color had lower standardized test scores than their White and Other peers. This disparity is aligned with larger trends at the national level. Although there were differences in test scores by race/ethnicity, for both groups, the average test scores exceeded the national average. Nonetheless, even among these advanced students, the exploratory findings suggest that objective academic strain can be negatively related to STEM research career plans for students within certain interventions. Since students of color had higher levels of objective academic strain, it is important to consider this relationship in order to fully understand outcomes for these students and how best to serve their needs in intervention settings.

Theoretical Relationships to Explore in Future Analyses

This research suggests that there are a number of different factors to consider when examining how summer research interventions influence outcomes in STEM fields for underrepresented students. More specifically, in order to understand how these interventions can promote positive outcomes, it is important to acknowledge how other factors can impede or enhance outcomes in addition to the intervention experience. These include strains due to finances, academic background, race, gender, and major choice, as well as students' multilevel strengths. Figure 5.1 outlines an emerging conceptual framework for understanding intervention efficacy within the context of these additional important factors. The framework provides an illustration of how the intervention and other factors combine to influence students' advanced

STEM career plans based upon existing literature and findings from this particular study. Although the results from this study are exploratory, they provide a nuanced interpretation of how interventions operate within a complex system of other important student characteristics to influence students' career plans in STEM. This framework could help to inform future research that seeks to fully understand intervention outcomes. The analyses that support each of the relationships in the conceptual framework are noted within the figure. Additionally, relationships that are represented in the model because of evidence within the broader literature are also distinguished.

Similar to other research concerning the influence of financial and academic challenges on college outcomes (e.g. Museus, Palmer, Davis & Maramba, 2011; Smedley, Myers and Harrell, 1993; St. John, Hu & Fisher, 2011; St. John & Musoba, 2010), this study suggested that financial and academic strain can negatively impact students' advanced STEM career plans. As previously noted, the analyses provided support for objective and subjective student role strain within financial and academic domains. Although these role strain domains emerged as separate constructs, the findings suggested that the constructs were related. Exploratory evidence indicated that these strains can directly impact students' advanced STEM career plans, and that the relationship between strain and the outcome can be mediated by STEM major choice. Furthermore, preliminary analyses suggested that students' strengths can help to buffer the negative effects of academic strain.

In addition to financial and academic student role strains, the results from this study suggest that racial and gender strains may also exist, and are important to note in order to understand intervention outcomes for underrepresented students. The study also suggested that women experienced a particular strain which can ultimately influence their outcomes within interventions. While both males and females in this study had similar levels of objective financial strain, females indicated higher levels of related subjective financial strain. Also, in this study, there were racial disparities in both financial and academic student role strain. Recall that racial differences emerged with regards to objective financial and academic barriers with students of color experiencing higher levels of strain than their White and Other peers. A framework that acknowledges the strains that may differentially impact females and students of color can help intervention stakeholders to understand overall outcomes in advanced STEM career plans for students in these groups.

A number of studies have noted gender and racial disparities in STEM majors and the resulting pool of STEM professionals (e.g. Hill, Corbett & St. Rose, 2010; National Action Council for Minorities in Engineering, 2008; National Science Foundation, 2013). Accordingly, some interventions have been developed to specifically target women and students of color in order to help to diversify STEM fields (e.g. Brainard and Carlin, 1998; Maton, Domingo, Stolle-McAllister, Zimmerman & Hrabowski, 2009; Pender, Marcotte, Domingo & Maton, 2010). This research aligns with existing literature by suggesting that gender is related to STEM major choice and students' plans to pursue advanced STEM careers. Additionally, preliminary evidence indicates that major may partially mediate the relationship between gender and advanced STEM career plans.

With regards to STEM major, the data suggested that students' major choice may have been related to their intervention participation. Recall that a higher percentage of STEM majors were CIC SROP and OSROP participants, compared to No SROP. Also, various analyses suggested that STEM major was related to the outcome[21]. This emphasizes the need to examine how intervention selection processes can ultimately influence outcomes and intervention efficacy.

Finally, while other research has highlighted positive relationships between intervention participation and outcomes in STEM fields, the study did not provide evidence of this direct relationship. However, preliminary analyses suggested moderating relationships between intervention participation and financial strain that should be considered in order to understand how interventions can influence outcomes in STEM fields. As shown in the framework, intervention experiences also relate to students' multilevel strengths. Other research has noted how intervention participation can promote positive outcomes by helping students to build personal strengths (e.g. Lopatto, 2007; Russell et al, 2006).

---

[21] While Table 4.5 is highlighted in Figure 5.1 with regards to the relationship between STEM major and advanced STEM career plans, other analyses within the study also supported this relationship (e.g. Tables 4.7, 4.8 and 4.9)

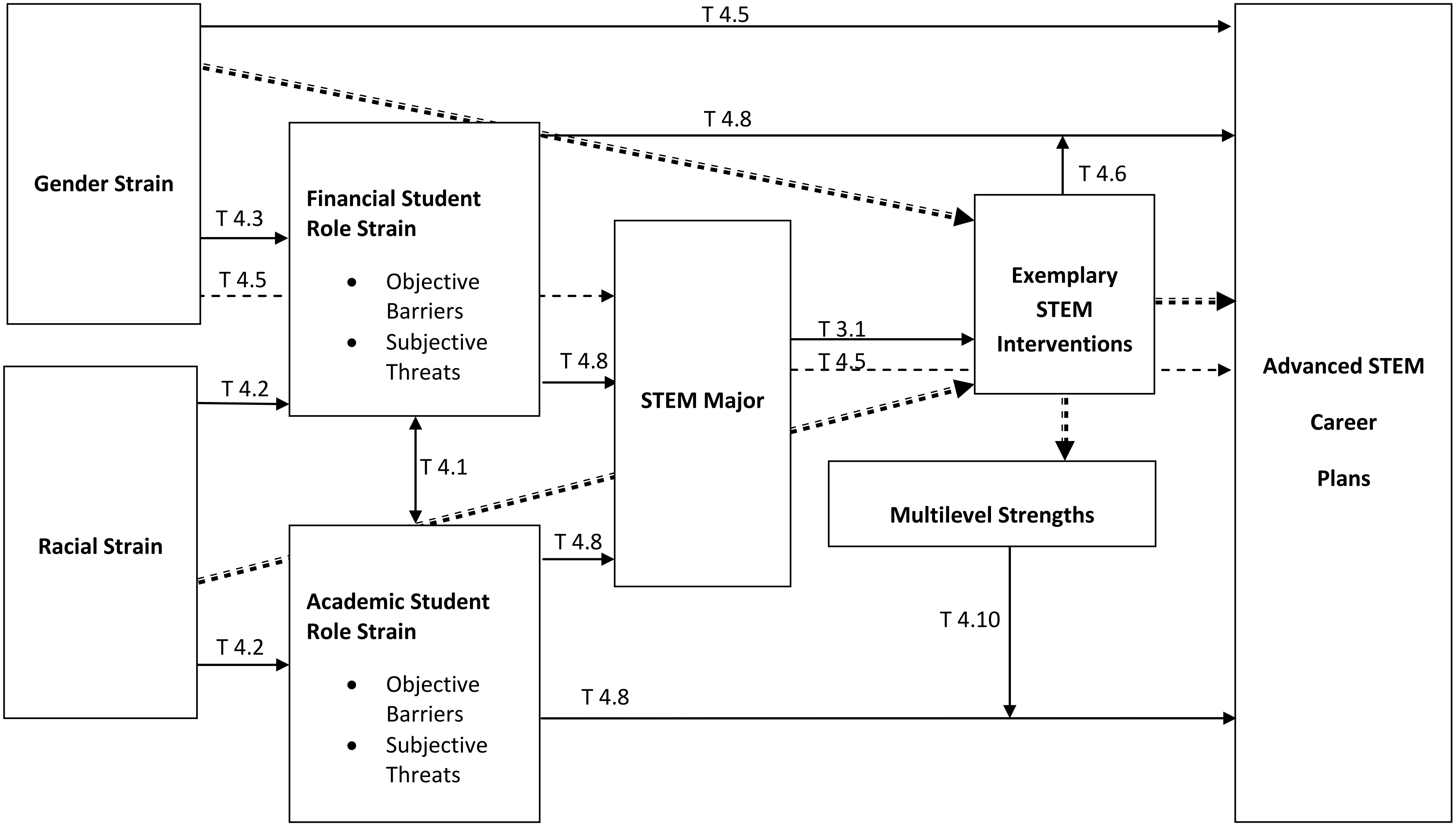


Figure 5.1. Emerging Conceptual Framework: Understanding Intervention Efficacy for Underrepresented Students

Note: The letter T represents the table that provides evidence for the relationship depicted in the figure; Also, --► *represents relationships that were not evident in this study, but were supported by the broader literature.*

Limitations and Implications for Future Research

There are a few limitations for this study that can help to inform future research. These limitations relate to (1) measurement, (2) modeling, (3) sample size, and (4) data. With regard to measurement, in some instances, single-item indicators were used to represent constructs. Specifically, because of data limitations, subjective financial role strain was operationalized using a single item. Given the limitations for using single items to represent complex constructs, future research should utilize appropriate techniques to develop more reliable and valid multiple-item scales for all role strain and adaption constructs (e.g. Allen & Yen, 1979; Devellis, 2012).

For pre-existing scales, psychometric techniques were employed to further validate their appropriate use in the present study. With regards to students' multilevel strengths, exploratory factor analysis (not shown) indicated that both personal resiliency and extended family support are multidimensional. Despite this finding, I created one measure for each of these scales because the broader constructs were better represented by combining all of the affiliated items. The Cronbach's Alpha Coefficients for each of these measures indicated acceptable levels of internal consistency when all of the related items were combined. Future research may investigate how the various dimensions of students' multilevel strengths and extended family support may relate to their advanced STEM career plans.

While measures of financial and academic challenges were employed to operationalize financial and academic role strain, there were no existing psychometric studies that investigated the use of these measures to represent the related constructs. Given the literature that suggests that students with financial hardships and academic preparation issues have barriers to overcome in higher education due to these challenges, it is feasible to employ these measures as indicators of strain. Accordingly, this study provides a foundation for conceptualizing what these measures represent within a student role strain framework. Additional research should further explore the use of these indicators within this framework.

There are also issues regarding modeling that are worth acknowledging. While this study examines students' receipt of Pell grants and/or college work study awards within the framework of role strain, no indicators for other types of aid are considered due to data limitations. It is possible that students may have received other types of financial assistance which might have helped to alleviate their immediate financial burdens. Controlling for these other financial resources may have allowed the financial barrier measures to better represents students' objective financial strain.

Also in terms of modeling, this study does not control for any pre-college research experiences students may have experienced. As previously noted, the push to increase the number and diversity of students pursuing STEM fields has become a focus for many policy discussions. Also, a number of interventions have been developed along the educational continuum to address STEM pipeline issues. In addition to programs at the collegiate level, there are also similar resources available to students at the K-12 level. Because these interventions exist at various stages in students' academic careers, future research should account for students' pre-college intervention experiences. Subsequent data collection efforts for the larger NIH-funded study inquired about such experiences for future use.

The outcome considered in this analysis is students' plans to pursue research careers in STEM fields. It is worth noting that CIC SROP and the other interventions considered in this analysis are not necessarily STEM specific. Many students who participate in these programs do so in a number of non-STEM fields. However, a large percentage of the students in these interventions are STEM majors and are likely mentored by faculty in these fields as part of the intervention. In fact, over half of the students considered in the study are STEM majors. Given the large percentage of students in these fields, this outcome is relevant despite the fact that the interventions are not STEM focused, solely.

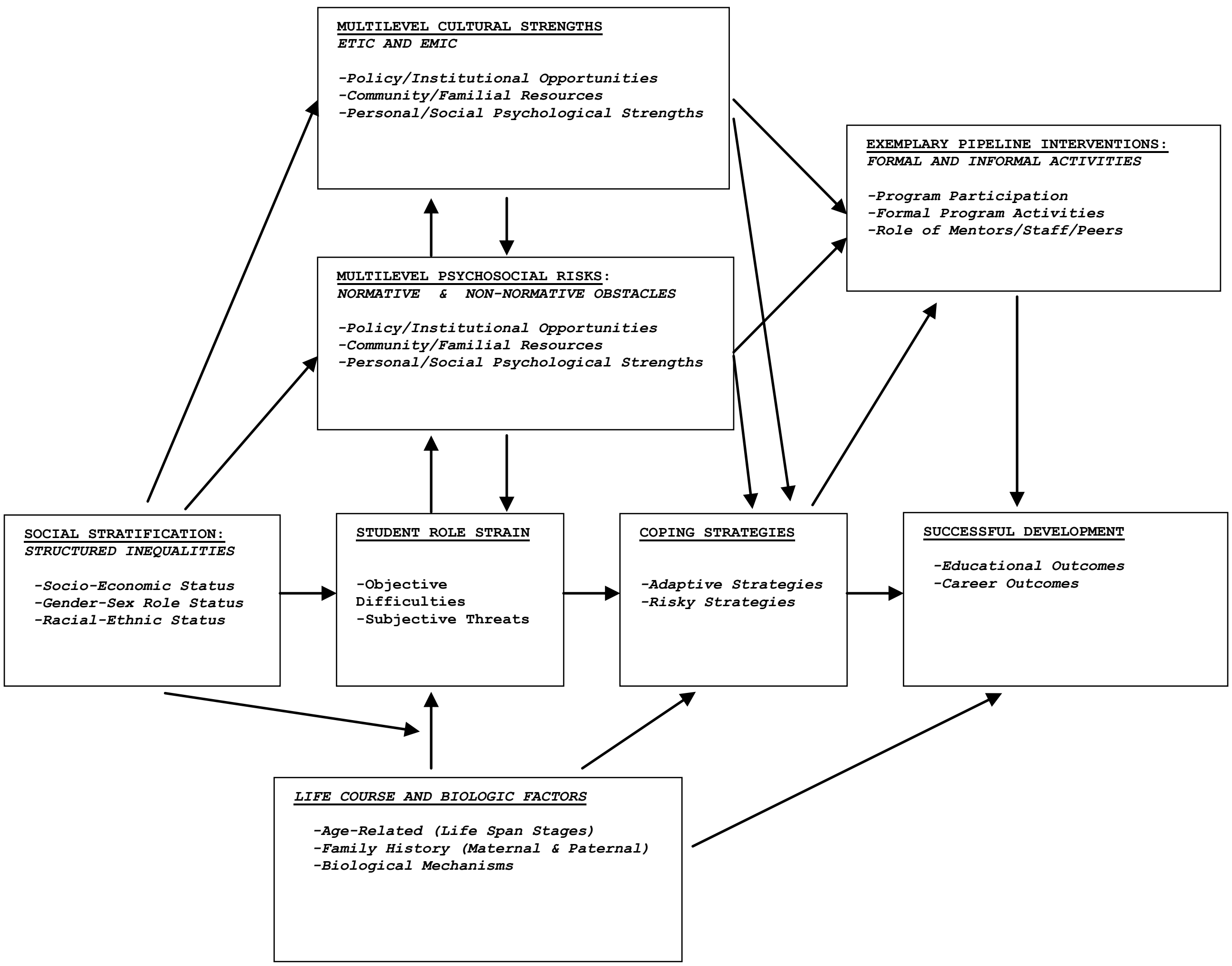
An additional limitation is with regard to the sample. Because of the limited sample size, there may not be enough power to adequately represent all the statistically significant relationships that exist. However, non-significant trends provide some insight about relationships that may manifest with a sufficient level of significance on a larger sample. Future work should use a larger sample to better investigate statistically significant relationships. Accordingly, the next phase of this research will include additional cohorts to increase sample size.

Also with regard to the data, many students who were enrolled in the study did not respond to the question regarding their STEM research career plans. Information regarding missing data on the outcome is included in Appendix E. Based on this analysis, there were only a few significant differences between the students who were and were not missing data on the outcome. On average, students with missing data had (1) lower high school grade point averages and (2) higher levels of extended family support. However, these differences were modest. It is also worth noting that the majority of students missing on the outcome were CIC SROP participants. Future research should investigate these issues further and consider possible imputation strategies.

Finally, as previously noted, this study explored how student strains and strengths relate to intervention outcomes as a means for better understanding the various factors that can influence student outcomes in addition to the intervention experience. This study involved intact groups; therefore, a randomized control study was not feasible. Because students were not randomly assigned to an intervention group, it was difficult to fully estimate the effects of intervention participation. While this analysis accounted for financial and academic challenges, student strengths and other characteristics that could also influence intervention outcomes, it is possible that other non-observable factors may also influence the STEM research career plans. Future research should explore additional approaches for estimating intervention effects. One approach would be to employ a pre-test/post-test model which controls for students' advanced STEM career plans before intervention participation.

Appendix A

The Bowman Role Strain and Adaptation Model



Adapted From:

Bowman, P.J. (2006). Role Strain and Adaptation Issues in the Strength-based Model: Diversity, Multilevel and Life Span Considerations. *Counseling Psychologist*, 34 (1), 118-133.

Appendix B

Descriptive Statistics for the Overall 2011 Cohort

	Total		CIC SROP		Non CIC SROP	
	%	(N)	%	(N)	%	(N)
Total	**100**	**(616)**	**51.0**	**(314)**	**49.0**	**(302)**
Gender						
Male	33.1	(179)	19.1	(103)	14.1	(76)
Female	66.9	(361)	33.1	(179)	33.7	(182)
Total	**100**	**(540)**	**52.2**	**(282)**	**47.8**	**(258)**
Race/Ethnic Background						
African American/Black/Negro	37.2	(194)	21.3	(111)	15.9	(83)
American Indian/Alaskan Native	1.7	(9)	1.1	(6)	0.6	(3)
Asian American	8.6	(45)	3.3	(17)	5.4	(28)
Native Hawaiian/Other Pacific Islander	0.6	(3)	0.4	(2)	0.2	(1)
White/Caucasian	30.5	(159)	13.2	(69)	17.2	(90)
Other	21.5	(112)	12.1	(63)	9.4	(49)
Total	**100**	**(522)**	**51.3**	**(268)**	**48.7**	**(254)**
Hispanic Background						
Yes	33.8	(185)	19.4	(106)	14.5	(79)
No	66.1	(361)	32.4	(177)	33.7	(184)
Total	**100**	**546**	**51.8**	**(283)**	**48.2**	**(263)**
Age						
18	0.6	(3)	0.2	(1)	0.4	(2)
19	4.6	(25)	1.3	(7)	3.3	(18)
20	17.5	(95)	8.9	(48)	8.7	(47)
21	39.9	(216)	21.8	(118)	18.1	(98)
22 or Over	37.5	(203)	19.7	(107)	17.7	(96)
Total	**100**	**(542)**	**51.8**	**(281)**	**48.2**	**(261)**
Mother's Education (Years)						
1-8 years	4.2	(17)	1.7	(7)	2.5	(10)
9-11 years	4.9	(20)	3.2	(13)	1.7	(7)
High School Graduate	20.2	(82)	10.1	(41)	10.1	(41)
Some College	21.7	(88)	12.1	(49)	9.6	(39)
4-year Degree	26.6	(108)	13.3	(54)	13.3	(54)
Masters Degree	15.8	(64)	7.9	(32)	7.9	(32)
Doctoral Degree	5.4	(22)	2.7	(11)	2.7	(11)
No Sure	1.2	(5)	1.0	(4)	0.2	(1)
Total	**100**	**(406)**	**52.0**	**(211)**	**48.0**	**(195)**

Father's Education (Years)						
1-8 years	4.4	(18)	2.2	(9)	2.2	(9)
9-11 years	8.2	(33)	5.2	(21)	3.0	(12)
High School Graduate	22	(89)	10.9	(44)	11.1	(45)
Some College	18.1	(73)	10.9	(44)	7.2	(29)
4-year Degree	20.8	(84)	10.6	(43)	10.1	(41)
Masters Degree	14.4	(58)	5.4	(22)	8.9	(36)
Doctoral Degree	8.4	(34)	4.7	(19)	3.7	(15)
No Sure	3.7	(15)	2.0	(8)	1.7	(7)
Total	**100**	**(404)**	**52.0**	**(210)**	**48.0**	**(194)**
Family Background Composition						
Both parents	70.4	(286)	37.2	(151)	33.3	(135)
Mother only	23.6	(96)	11.1	(45)	12.6	(51)
Father only	2.2	(9)	0.5	(2)	1.7	(7)
Other guardians	3.7	(15)	2.5	(10)	1.0	(5)
Total	**100**	**(406)**	**51.2**	**(208)**	**48.8**	**(198)**
Ethnic Diversity of High School Attended						
All/Almost all persons of my ethnic group	27.2	(110)	13.6	(55)	13.6	(55)
Mostly persons of my ethnic group	20.5	(83)	10.6	(43)	9.9	(40)
About half person of my ethnic group	20.7	(84)	8.9	(36)	11.9	(48)
Mostly persons of other ethnic groups	18	(73)	9.6	(39)	8.4	(34)
All/Almost all persons of other ethnic group	13.6	(55)	8.4	(34)	5.2	(21)
Total	**100**	**(405)**	**51.1**	**(207)**	**48.9**	**(198)**
Ethnic Diversity of Current College						
All persons of my ethnic group	21.8	(89)	11.5	(47)	10.3	(42)
Mostly persons of my ethnic group	20.3	(83)	9.1	(37)	11.3	(46)
Half persons of my ethnic group	17.9	(73)	7.6	(31)	10.3	(42)
Mostly persons of other ethnic groups	21.8	(89)	11.8	(48)	10.0	(41)
All persons of other ethnic group	18.1	(74)	11.5	(47)	6.6	(27)
Total	100	(408)	51.5	(210)	48.5	(198)
Ethnic Diversity of Childhood Neighborhood						
All persons of my ethnic group	41	(166)	20.2	(82)	20.7	(84)
Mostly persons of my ethnic group	20.2	(82)	10.4	(42)	9.9	(40)
Half persons of my ethnic group	13.3	(54)	5.9	(24)	7.4	(30)
Mostly persons of other ethnic groups	13.6	(55)	7.9	(32)	5.7	(23)
All persons of other ethnic group	11.9	(48)	7.2	(29)	4.7	(19)
Total	100	(405)	51.6	(209)	48.4	(196)

Ethnic Diversity of Current Neighborhood						
All persons of my ethnic group	30.8	(125)	14.8	(60)	16.0	(65)
Mostly persons of my ethnic group	22.2	(90)	12.1	(49)	10.1	(41)
Half persons of my ethnic group	13.8	(56)	5.9	(24)	7.9	(32)
Mostly persons of other ethnic groups	17	(69)	9.9	(40)	7.1	(29)
All persons of other ethnic group	16.3	(66)	8.9	(36)	7.4	(30)
Total	100	(406)	51.5	(209)	48.5	(197)

Appendix C

Survey Items for each Construct

Construct	*Survey Questions*	*Scale/Response Options*
Advanced STEM Career Plans	If you try, how certain are you that you will pursue a research career in some Science, Technology, Engineering, or Mathematics field?	5-point Likert-type scale that ranged from "completely certain I will not" to "completely certain I will"
Financial Role Strain: **Objective Barriers and Subjective Threats**		
Pell and/or College Work Study Award	When you entered college, did you receive 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
Public Assistance Usage	During any periods of unemployment or economic hardship, was your family ever able to receive unemployment or other kinds of assistance?	Never needed assistance; Unemployment benefits; Food Stamps or assistance; Rent or housing assistance; Other types of assistance received
Financial Discouragement	During the last term, how well did you actually keep other problems (i.e. money, transportation, family and personal) from hurting your school performance?	5-point Likert-type scale that ranged from "did not try at all" to "tried very hard"
Financial Stress	How much have the following problems bothered you during the past school year? • Personal money or financial	4-point Likert-type scale that ranged from "hasn't bothered me at all" to "bothered me a great deal"

	problems • Personal job problems	
Academic Role Strain: **Objective Barriers and Subjective Threats**		
High School Grade Point Average	What was your overall high school GPA?	(open-response question)
ACT Score	What were your ACT/SAT scores- your total and subscores, if you remember? If you don't remember, please give your best estimate.	(open-response question)
Ability Blame	Rate the degree to which you agree or disagree with the following statements about your general orientation and experiences in academic settings. • If I were to fail a course it would probably be because I lacked skill in that area • If I were to get poor grades I would assume that I lacked ability to succeed in those courses • If I were to receive low marks, it would cause me to question my academic ability	4-point Likert-type scale that ranged from "strongly disagree" to "strongly agree"
Academic Discouragement	Please indicate how much you agree or disagree with the following statements about your academic experiences so far: • Generally, I have found my class	4-point Likert-type scale that ranged from "strongly disagree" to "strongly agree"

	work quite easy • When my grades have been lower than expected, I have often felt discouraged • I have usually been able to improve my lower exam grades • If my grades don't improve, I may not pursue advanced graduate/ professional studies and just get a job • I am confident that I will graduate from college • Even if I tried, graduating with honors is impossible • With the right strategies, I can still achieve most of the academic goals I set for college • Like many students, I will probably never achieve college grades as good as my high school grades	
Multilevel Strengths		
Personal Resiliency	Rate the degree to which the following statements are true for you (personally): • I've always felt that I could make	4-point Likert-type scale that ranged from "completely false" to "completely true"

	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 that 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 believe 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 the 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	
Family Support	How supportive would the following people be if you decided to pursue a Ph.D. degree? • Mother/Stepmother • Father/Stepfather • Sister (Brother) you feel closest to • Grandmother (Grandfather) you feel closest to • Aunt (Uncle) you feel closest to • Female (Male) Cousin you feel closest to • Best female (male) friend • Adult at past high school you feel closest to • Adult member of your place of worship who you feel especially close to • Other adult "friend or family" you feel close to	5-point Likert-type scale that ranged from "does not apply" to "extremely supportive"

Background Characteristics		
Gender	Your sex is:	Male; Female
Race	Are you of Hispanic, Latino, or Spanish origin? With which racial/ethnic/cultural background do you primarily identify?	Yes; No 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

Appendix D

Measure Coding and Description

Measure	Description
Objective Financial and Academic Barriers	
Used Public Assistance	1: Yes; 0: No
Awarded Pell and/or College Work Study†	1: Yes; 0: No
Lower High School GPA†*	Overall high school grade point average
Lower ACT Score†*	Total ACT score
Subjective Financial and Academic Threats	
Financial Discouragement†	1: Tried very hard to keep money and other problems from hurting school;
Financial Stress#	Degree to which students were bothered by personal money, financial or personal job problems during the previous school year
Ability Blame†	Degree to which students attribute their academic challenges to ability limitations (Multidimensional Multi-Attribution Causality Scale)
Academic Discouragement†	Degree to which students felt discouraged academically (Feldman Index)
Multilevel Strengths	
Personal Resiliency	Self-perception about an individual's ability to employ hard work and determination to meet environmental demands (John Henryism)
Family Support	Perceived support towards the PhD from family members including the nuclear family, intergenerational kin, and para-kin (Reyes Scale)
Background Characteristics	
Male	1: Male; 0: Female
Underrepresented Minority†	1: American/Black/Negro, American/Indian/Alaskan Native, Asian American, Native Hawaiian/Other Pacific Islander, or Hispanic/Latino

STEM Major†	1: Biomedical/Behavioral Sciences major; Other Basic or Applied Sciences major (e.g. Physics, Engineering, etc.); 0: Social Sciences/Related Professions (e.g. Sociology, law, etc.); Creative Arts/Related Professions (e.g. Theater, Art, Dance, etc.); or Major Undecided

† Recodes of the original variables in the dataset

New construct; developed with psychometric techniques

* Multiplied by -1 to represent strain

Appendix E

Missing Data Analysis

Missing Data Analysis: Comparisons of Respondents Missing and Not Missing on STEM Research Career Plans

	Not Missing (N=398)		Missing (N=221)		
	Mean	SD	Mean	SD	p
Objective Fin & Acad Role Barriers					
Used Public Assistance (dummy coded, 0=no, 1=yes)	0.42	-	0.43	-	n.s.
Awarded Pell and/or College Work Study (dummy coded, 0=no, 1=yes)	0.60	-	0.63	-	n.s.
High school GPA	3.69	0.49	3.57	0.50	~
ACT score	25.63	5.29	24.45	5.38	n.s.
Subjective Fin & Acad Role Threats					
Financial Stress (a)	0.00	1.00	0.01	0.99	n.s.
Ability Blame (a)	0.00	1.02	-0.07	0.96	n.s.
Academic Discouragement (a)	0.00	1.00	0.02	1.05	n.s.
Multilevel Strengths					
Personal Resiliency (a)	0.01	1.03	-0.06	1.02	n.s.
Extended Family Support (a)	-0.05	1.00	0.16	1.03	~
Background Characteristics					
Male (dummy coded, 0=female, 1=male)	0.31	-	0.37	-	n.s.
Underrepresented Minority (dummy coded, 0=no, 1=yes)	0.66	-	0.68	-	n.s.
STEM Major (dummy coded, 0= Non STEM major, 1=STEM major)	0.64	-	0.65	-	n.s.

(a) Variables are z-scores (M=0; SD=1); The outcome variable is also standardized
(b) SD presented for continuous variables; not relevant for dummy-coded (categorical) variables.

Appendix F

Estimated Intervention Effects

The primary objective of this theory driven study is not to evaluate summer research interventions, but it is important to estimate intervention effects on outcomes. CIC SROP and similar programs are designed to encourage students to pursue doctoral studies and faculty careers. The information in Figure 4.1 provides insight about students' advanced STEM career plans. This study focuses specifically on how intervention participation, student role strains and multilevel strengths influence research career plans in STEM areas. While this outcome is not a direct objective of CIC SROP and similar interventions, it is highly related to these programs' mission to encourage students to pursue faculty research careers. Also, as previously noted, a number of the students in these interventions are STEM majors. Accordingly, this outcome is particularly relevant. Figure 4.1 provides information regarding students' certainty that they will pursue a research career in some STEM field. These plans were measured before intervention participation and one year after intervention participation, using a Likert scale from one to five where a higher score indicates a greater degree of certainty.

On average, CIC SROP students are highly certain that they will pursue a research career in a STEM field before the intervention, and their plans for this career path increased slightly from Time 1 to Time 3. While No SROP students start with a lower degree of certainty about a future research career in STEM, they experience a similar increase in these plans from Time 1 to Time 3. The findings are quite different for OSROP students. These students have initial STEM research career plans that are similar to those of CIC SROP students. However, OSROP students' plans to pursue this career path decrease from Time 1 to Time 3. These findings suggest that CIC SROP participation can have a positive effect on students' advanced STEM research career plans, but that this effect may differ from similar research opportunity programs. Accordingly, it is important to examine these two intervention experiences separately and how they influence students' career plans.

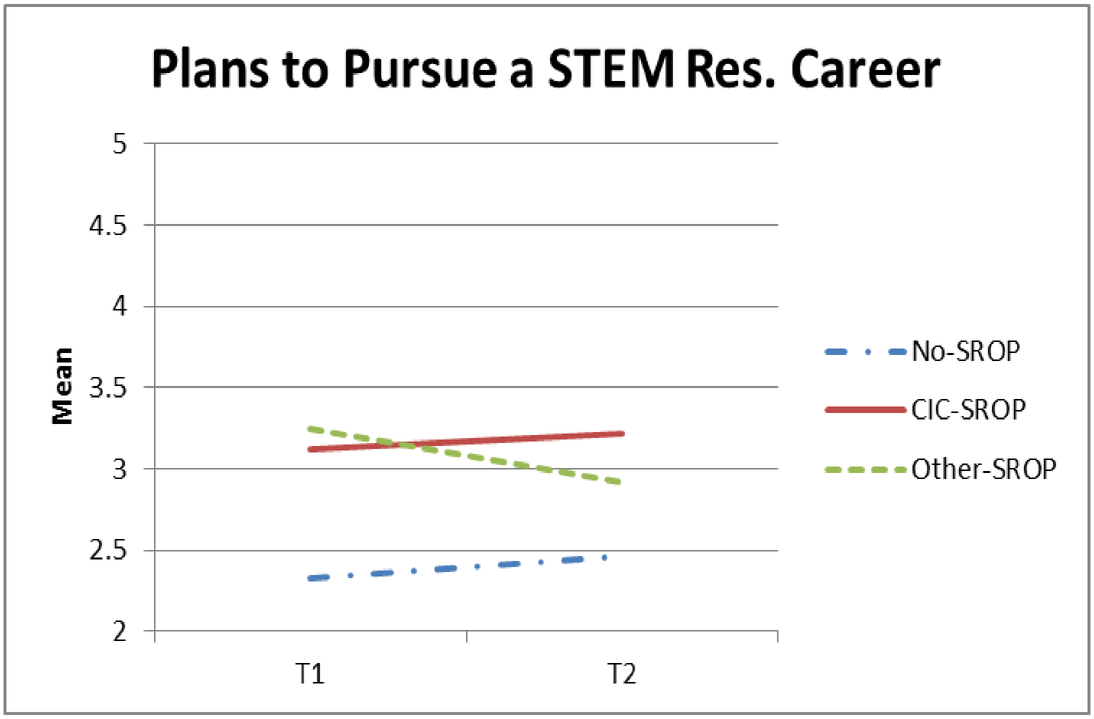


Figure 4.1. Change in Plans to Pursue a STEM Research Career for CIC SROP, OSROP and No SROP Students

Appendix G

Correlation Matrix for Measures in Hierarchical Regression Analyses

	STEM Research Career Plans	CIC SROP	OSROP	No SROP	Public Assistance	Awarded Pell/Work Study	High School GPA (a)	Lower ACT Score (a)	Financial Stress	Ability Blame	Academic Discouragement	Personal Resiliency	Extended Family Support	Male	Underrepresented Minority
CIC SROP	.135 **														
OSROP	.011	-.594 ***													
No SROP	-.170 ***	-.577 ***	-.315 ***												
Public Assistance	-.018	.013	-.009	-.006											
Awarded Pell/Work Study	-.135 *	.053	-.040	-.022	.296 ***										
Lower High School GPA (a)	.024	-.001	-.111 ~	.112 ~	.014	-.043									
Lower ACT Score	-.118 ~	.077	-.055	-.033	.116 ~	.090	.222 **								
Financial Stress	-.126 *	.028	-.078	.044	.187 **	.216 ***	.108 ~	.131 *							
Ability Blame	.065	-.016	-.018	.037	.080	-.098 ~	-.110 ~	.062	.089						
Academic	.087	.013	-.034	.018	.046	.038	-.146 *	-.106	.156 **	.273 ***					
Personal Resiliency	.049	.001	.030	-.031	-.016	.024	.033	.090	-.046	-.210 ***	-.348 ***				
Extended Family Support	.019	.121 *	-.089	-.051	-.156 **	-.098 ~	-.076	-.031	-.143 *	-.113 ~	-.040	.226 ***			
Male	.236 ***	.106 ~	.017	-.140 **	-.022	-.068	.091	-.024	-.122 *	-.074	-.045	.087	.039		
Underrepresented Minority	-.089 ~	.167 **	-.104 ~	-.093 ~	.116 ~	.162 **	.069	.253 ***	.052	-.088	-.082	.078	-.012	-.003	
STEM Major	.608 ***	.125 *	.047	-.192 **	-.050	-.120 *	.017	-.151 *	-.109 ~	.031	.143 *	.019	.045	.166 **	-.060

~ p<.10; * p<.05; ** p<.01; *** p<.001

(a) Reverse coded to represent strain

+`

Appendix H

Supplemental Moderating Effects Analysis

Hierarchical Regression Analysis Assessing the Moderating Effects of Intervention Participation on Advanced STEM Career Plans (a) According to Student Role Strain—Excluding STEM major (n=398)

	Models	
Independent Variables	Model 1: Student Role Strain & Background	Model 2: Interactions
Intervention		
CIC-SROP	0.425 *	1.012 **
OSROP	0.286	0.726 *
Objective Fin & Acad Role Barriers		
Used Public Assistance	0.077	0.077
Awarded Pell and/or college work study	-0.190	0.471
Low High school GPA (a) (b)	0.076	0.072
Low ACT score (a) (b)	-0.102	-0.102
Subjective Fin & Acad Role Threats		
Financial Stress (a)	-0.096	-0.301 *
Ability Blame (a)	0.064	0.069
Academic Discouragement (a)	0.090	0.220
Background		
Male	0.418 **	0.422 **
Underrepresented Minority	-0.132	-0.148
Interactions		
Pell/WS x CIC SROP		-0.950 *
ACT x CIC SROP		-0.019
Financial Stress x CIC SROP		0.307 ~
Academic Discouragement x CIC SROP		-0.146
Pell/WS x OSROP		-0.762 ~
ACT x OSROP		-0.014
Financial Stress x OSROP		0.246
Academic Discouragement x OSROP		-0.213
Constant	-0.240	-0.678 **
R^2	0.131 **	0.168 **
Change in R^2		0.037

~ p<.10; * p<.05; ** p<.01; *** p<.001; Unstandardized coefficients reported

(a) Variables are z-scores (M=0; SD=1)

(b) Reverse coded to represent strain; The outcome variable is also standardized

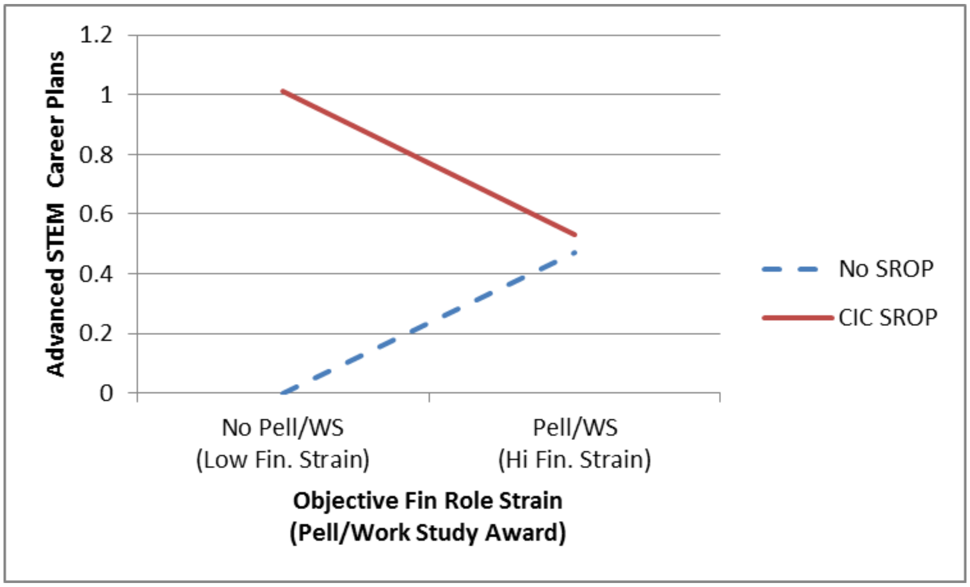


Figure H.1. Exploratory Moderating Effect of CIC SROP participation on Objective Financial Student Role Strain

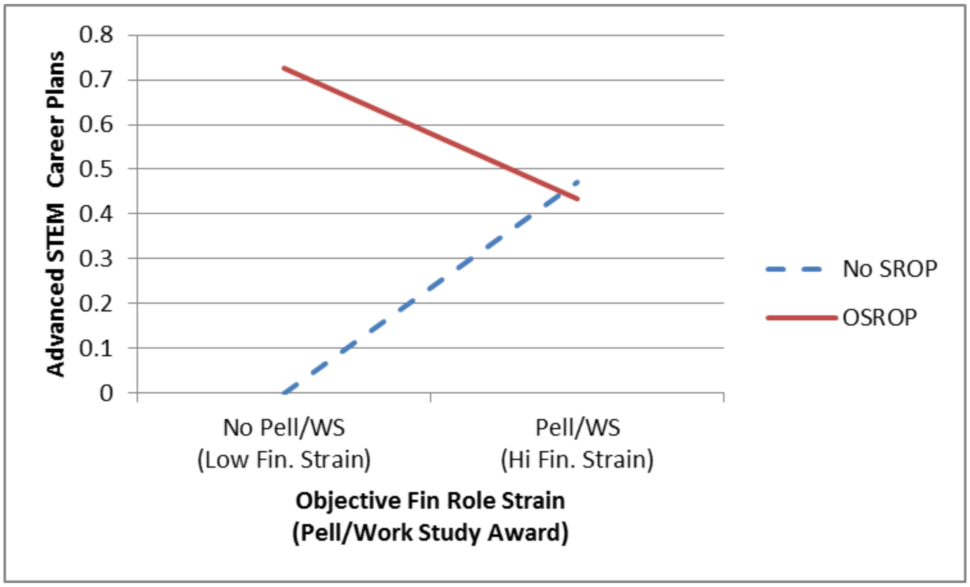


Figure H.2. Exploratory Moderating Effect of OSROP participation on Objective Financial Student Role Strain

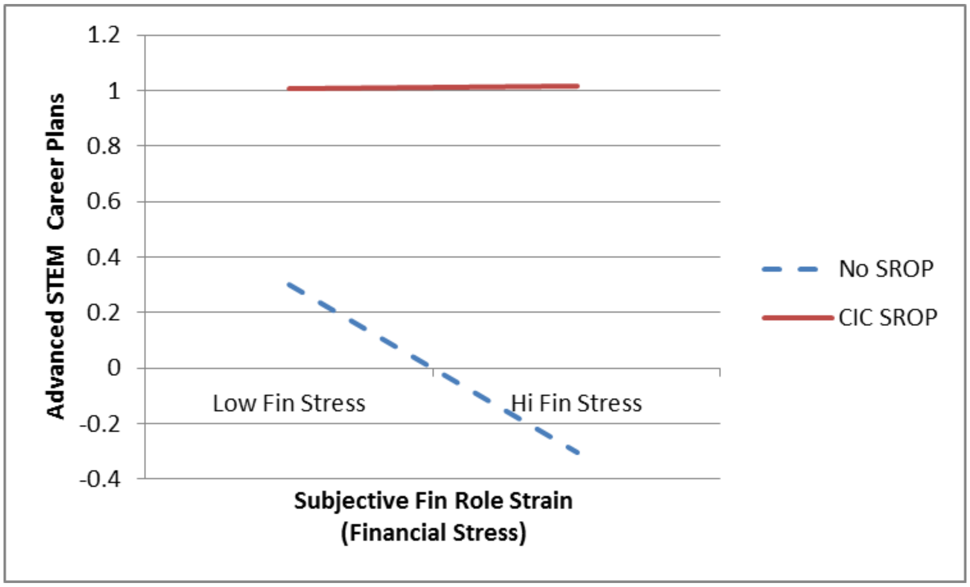


Figure H.3. Exploratory Moderating Effect of CIC SROP participation on Subjective Financial Student Role Strain

Appendix I

Supplemental Buffering Effects Analysis

Hierarchical Regression Analysis Assessing Whether Multilevel Strengths Buffer the Relationship between Student Role Strain and Advanced STEM Career Plans (a) (n=398)

	Models			
Independent Variables	Model 1: Student Role Strain, Multilevel Strengths & Background		Model 2: Buffering Model	
Intervention				
CIC-SROP	0.432	*	0.438	*
OSROP	0.278		0.320	
Objective Fin & Acad Role Strain				
Used Public Assistance	0.072		0.088	
Awarded Pell and/or college work study	-0.198		-0.197	
High school GPA (a) (b)	0.078		0.072	
ACT score (a) (b)	-0.109		-0.084	
Subjective Fin & Acad Role Strain				
Financial Stress (a)	-0.101		-0.118	
Ability Blame (a)	0.074		0.071	
Academic Discouragement (a)	0.123		0.091	
Multilevel Strengths				
Personal Resiliency (John Henryism) (a)	0.106		0.019	
Extended Family Support (a)	-0.031		0.017	
Background				
Male	0.402 **		0.389 *	
Underrepresented Minority	-0.139		-0.153	
Key Interactions				
Personal Resiliency x Pell/WS			0.135	
Personal Resiliency x ACT			0.122	
Personal Resiliency x Financial Stress			-0.058	
Personal Resiliency x Acad. Discouragment			-0.053	
Extended Family Support x Pell/WS			-0.071	
Extended Family Support x ACT			0.044	
Extended Family Support x Financial Stress			0.000	
Extended Family Support x Acad. Discouragement			0.043	
Constant	-0.223		-0.263	
R^2	0.374 **		0.408 *	
Change in R^2			0.026	

~ p<.10; * p<.05; ** p<.01; *** p<.001
(a) Variables are z-scores (M=0; SD=1);
(b) Reverse coded to represent strain;
Unstandardized coefficients reported

Appendix J

Subgroup Analyses of Buffering Effects

Hierarchical Regression Analysis Assessing Whether Multilevel Strengths Buffer the Relationship between Student Role Strain and Advanced STEM Career Plans (a)— CIC Subgroup (n=196)

	Models				
Independent Variables	Model 1: Fin & Acad Role Strain (Objective)	Model 2: Fin & Acad Role Strain (Subjective)	Model 3: Multilevel Strengths	Model 4: Selected Background	Model 5: Interaction Model
Objective Fin & Acad Role Barriers					
Used Public Assistance	-0.124	-0.108	-0.134	-0.270	-0.235
Awarded Pell and/or college work study	-0.405 ~	-0.412 ~	-0.423 ~	-0.099	-0.147
Low High school GPA (a) (b)	0.095	0.128	0.114	0.059	0.037
Low ACT score (a) (b)	-0.121	-0.139	-0.123	0.056	0.036
Subjective Fin & Acad Role Threats					
Financial Stress (a)		-0.015	-0.013	0.052	0.044
Ability Blame (a)		0.054	0.043	0.058	0.060
Academic Discouragement (a)		0.080	0.083	-0.090	-0.122
Multilevel Strengths					
Personal Resiliency (a)			0.010	-0.001	-0.003
Extended Family Support (a)			-0.082	-0.092	-0.179
Background					
Male				0.229	0.243
Underrepresented Minority				-0.098	-0.080
STEM Major				1.361 ***	1.417 ***
Interactions					
Personal Resiliency x Pell/WS					0.022
Personal Resiliency x ACT					0.078
Personal Resiliency x Financial Stress					0.014
Personal Resiliency x Acad. Discouragment					0.007
Extended Family Support x Pell/WS					0.144
Extended Family Support x ACT					0.075
Extended Family Support x Financial Stress					0.085
Extended Family Support x Acad. Discouragement					0.029
Constant	0.467 **	0.467 **	0.491 **	-0.625 *	-0.667 **
R^2	0.072	0.083	0.090	0.476 ***	0.501 ***
Change in R^2		0.011	0.007	0.386 ***	0.364

~ p<.10; * p<.05; ** p<.01; *** p<.001; Unstandardized coefficients reported

(a) Variables are z-scores (M=0; SD=1); (b) Reverse coded to represent strain

Hierarchical Regression Analysis Assessing Whether Multilevel Strengths Buffer the Relationship between Student Role Strain and Advanced STEM Career Plans (a) —OSROP Subgroup

	Models				
Independent Variables	Model 1: Fin & Acad Role Strain (Objective)	Model 2: Fin & Acad Role Strain (Subjective)	Model 3: Multilevel Strengths	Model 4: Selected Background	Model 5: Interaction Model
Objective Fin & Acad Role Barriers					
Used Public Assistance	0.659 *	0.650 ~	0.731 *	0.533 *	0.765 *
Awarded Pell and/or college work study	-0.139	-0.023	0.079	0.091	0.114
Low High school GPA (a) (b)	0.175	0.203	0.204	-0.034	-0.014
Low ACT score (a) (b)	-0.298 *	-0.294 ~	-0.302 *	-0.222 ~	-0.210
Subjective Fin & Acad Role Threats					
Financial Stress (a)		-0.124	-0.081	0.110	0.154
Ability Blame (a)		0.115	0.181	0.171	0.233 ~
Academic Discouragement (a)		-0.068	-0.025	-0.059	-0.122
Multilevel Strengths					
Personal Resiliency (a)			0.288 ~	0.004	-0.217
Extended Family Support (a)			0.120	0.141	0.172
Background					
Male				0.585 *	0.749 *
Underrepresented Minority				0.175	0.140
STEM Major				1.175 ***	1.601 ***
Interactions					
Personal Resiliency x Pell/WS					0.134
Personal Resiliency x ACT					-0.166
Personal Resiliency x Financial Stress					-0.065
Personal Resiliency x Acad. Discouragment					0.237 ~
Extended Family Support x Pell/WS					0.050
Extended Family Support x ACT					0.227
Extended Family Support x Financial Stress					-0.199
Extended Family Support x Acad. Discouragment					-0.259 ~
Constant	-0.140	-0.214	-0.282	-1.316 ***	-1.663 ***
R^2	0.161 ~	0.194	0.294 ~	0.565 **	0.677 **
Change in R^2		0.033	0.100 ~	0.270 **	0.113

~ p<.10; * p<.05; ** p<.01; *** p<.001; Unstandardized coefficients reported

(a) Variables are z-scores (M=0; SD=1); (b) Reverse coded to represent strain

Hierarchical Regression Analysis Assessing Whether Multilevel Strengths Buffer the Relationship between Student Role Strain and Advanced STEM Career Plans (a) —No SROP Subgroup

	Models				
Independent Variables	Model 1: Fin & Acad Role Strain (Objective)	Model 2: Fin & Acad Role Strain (Subjective)	Model 3: Multilevel Strengths	Model 4: Selected Background	Model 5: Interaction Model
Objective Fin & Acad Role Barriers					
Used Public Assistance	-0.219	-0.149	-0.193	0.044	0.058
Awarded Pell and/or college work study	0.132	0.246	0.265	0.166	0.245
Low High school GPA (a) (b)	0.016	-0.002	0.020	0.000	0.033
Low ACT score (a) (b)	-0.138	-0.051	-0.097	0.055	0.020
Subjective Fin & Acad Role Threats					
Financial Stress (a)		-0.206	-0.248	-0.165	-0.140
Ability Blame (a)		0.054	0.104	-0.010	0.044
Academic Discouragement (a)		0.273 ~	0.316 ~	0.220	0.216
Multilevel Strengths					
Personal Resiliency (a)			0.232	0.232	0.036
Extended Family Support (a)			-0.211	-0.181	0.066
Background					
Male				-0.019	-0.071
Underrepresented Minority				-0.413	-0.482
STEM Major				0.693 *	0.742 *
Interactions					
Personal Resiliency x Pell/WS					0.408
Personal Resiliency x ACT					0.097
Personal Resiliency x Financial Stress					0.084
Personal Resiliency x Acad. Discouragment					0.125
Extended Family Support x Pell/WS					-0.507
Extended Family Support x ACT					0.143
Extended Family Support x Financial Stress					-0.087
Extended Family Support x Acad. Discouragment					-0.084
Constant	-0.287	-0.374	-0.380	-0.48	-0.544
R^2	0.024	0.142	0.197	0.359	0.451
Change in R^2		0.118	0.056	0.161 ~	0.093

~ $p<.10$; * $p<.05$; ** $p<.01$; *** $p<.001$; Unstandardized coefficients reported

(a) Variables are z-scores (M=0; SD=1); (b) Reverse coded to represent strain

REFERENCES

Abouserie, R. (1994). Sources and levels of stress in relation to locus of control and self esteem in university students. *Educational Psychology*, *14*(3), 323-330.

Adelman, C. (1999). *Answers in the tool box: Academic intensity, attendance patterns, and bachelor's degree attainment.* Washington, DC: U.S. Department of Education.

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college.* Washington, DC: U.S. Department of Education.

Advisory Committee on Student Financial Aid. (2010). *The rising price of inequality: How inadequate grant aid limits college access and persistence.* Washington, DC.

Aitken, N. D. (1982). College student performance, satisfaction, and retention: Specification and estimation of a structural model. *Journal of Higher Education 53*(1), 22-50.

Akgun, S., & Ciarrochi, J. (2003). Learned resourcefulness moderates the relationship between academic stress and academic performance. *Educational Psychology*, *23*, 287-294.

Alexander, C., Chen, E., & Grumbach, K. (2009). How leaky is the health career pipeline? Minority student achievement in college gateway courses. *Academic Medicine, 84*, 797-802.

Allen, M. J. & Yen, W. M. (1979). *Introduction to measurement theory.* Long Grove, IL: Waveland Press.

American Psychological Association (2010). Psychology as a core science, technology, engineering, and mathematics (STEM) discipline. Retrieved from://www.apa.org/science/about/psa/2010/08/stem-report.pdf

Anderson, E., & Kim, D. (2006). *Increasing the success of minority students in science and technology.* Washington, DC: American Council on Education.

Association for American Universities (n.d.). AAU undergraduate STEM education initiative. Retrieved from http://www.aau.edu/policy/article.aspx?id=12588

Astin, A.W. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development, 40* (5), 518-529.

Babbie, E. R. (1990). *Survey research methods* (Vol. 2). Belmont, CA: Wadsworth Publishing Company.

Bandura, A. (1997). Self-efficacy: The exercise of control. New York: W.H. Freeman.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Bauer, K. & Bennett, J. (2003). Alumni perceptions used to assess undergraduate research experience. *The Journal of Higher Education 74*(2), 210-230.

Bean, J. P. (1980). Dropouts and turnover: The synthesis and test of a causal model of students attrition process. *Research in Higher Education, 12*, 155-187.

Bean, J.P. (1982). Student attrition, intentions and confidence: Interaction effects in a path model. *Research in Higher Education, 14*, 425-429.

Bean, J.P. (1985). Interaction effects based on class level in and explanatory model of college student dropout syndrome. *American Educational Research Journal, 22*, 35-64.

Bean, J. P, & Metzner, B. S. (1985). A conceptual model of nontraditional undergraduate student attrition. *Review of Educational Research, 55*(4), 485-540.

Beede, D., Julian, T., Langdon, D., McKittrick, G., Khan, B., Doms, M. (2011). *Women in STEM: A gender gap to innovation.* Washington, DC: U.S. Department of Commerce Economics and Statistics Administration.

Belley, P., & Lochner, L. (2007). *The changing role of family income and ability in determining educational achievement* (No. w13527). National Bureau of Economic Research.

Betz, N.E. (2007). Career self-efficacy: exemplary recent research and emerging directions. *Journal of Career Assessment*, 15, 403-422.

Billingsley, A. (1992). *Climbing Jacob's ladder.* New York : Simon and Schuster.

Blank, R. M. (1997). *It takes a nation: A new agenda for fighting poverty*. Princeton, NJ : Princeton University Press

Blickenstaff, J. C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender & Education, 17,* 369–386.

Bloom, H. S., & Michalopoulos, C. (2013). When is the story in the subgroups? *Prevention Science, 14*(2) 179-188.

Blumenstyk, G. (2011, September 14). College spending trends show students bearing a growing share of the costs. *The Chronicle of Higher Education.* Retrieved from http://chronicle.com/article/College-Spending-Trends-Show/128972/

Bollinger, L. (2002, July 12). Debate over the SAT masks perilous trends in college admission. *Chronicle of Higher Education*, pp. B11-B12.

Bombardieri, M. (2005, January 19). Harvard women's group rips Summers. *The Boston Globe.* Retrieved from http://www.boston.com/news/education/higher/articles/2005/01/19/harvard_womens_group_rips_summers/

Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science, mathematics, and engineering majors. *Journal of Negro Education, 69*(1), 92-111.

Bowman, P.J. (2013). A strengths-based social psychological approach to resiliency: Cultural diversity, ecological and life span issues. In S. Prince-Embury (Ed.), R*esilience in children, adolescents, and adults* (pp. 299-325). New York, NY: Springer.

Bowman, P.J. (2011). Toward a strength-based assessment system: A comprehensive social psychological approach. In P.J. Bowman & E.P. St. John (Eds.), *Diversity, merit, and higher education: Readings on equal education*. New York, NY: AMS Press, Inc.

Bowman, P. J. (2006). Role strain and adaptation issues in the strength-based model: Diversity, multilevel, and life-span considerations. *Counseling Psychologist, 34*(1), 118-133.

Bowman, P. J., & Sanders, R. (1998). Unmarried African American fathers: A comparative life span analysis. *Journal of Comparative Family Studies, 29*(1), 39-56.

Boyer Commission (1998). *Reinventing undergraduate education: A blueprint for America's research universities*. Stony Brook, New York: Carnegie Foundation.

Boyer Commission (2002). *Reinventing undergraduate education: Three years after the Boyer report*. Stony Brook, New York: Carnegie Foundation.

Brainard, S., & Carlin, L. (1998). A six-year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education, 87*(4), 369-375.

Braunstein, A., McGrath, M., & Pescatrice, D. (1999). Measuring the impact of income and financial aid offers in college enrollment decisions. *Research in Higher Education*, *40*(3), 247-259.

Brazziel, M. E., & Brazziel, F. B. (2001). Factors in decisions of underrepresented minorities to forego science and engineering doctoral study: A pilot study. *Journal of Science Education and Technology, 10*, 273–281.

Bridgeman, B., McCamley-Jenkins, L., and Ervin, N. (2000). *Predictions of freshman grade-point average from the revised and recentered SAT I: Reasoning Test* (College Board Report No. 2000-1). New York: College Board.

Cabrera, A. F., Castenada, M. B., Nora, A., & Hengstler, D. (1992). The convergence between two theories of college persistence. *Journal of Higher Education, 63*(2), 143-164.

Cabrera, A. F., Nora, A., & Castañeda, M. B. (1992). The role of finances in the persistence process: A structural model. *Research in Higher Education, 33*(5), 571-594.

Cabrera, A. F., Nora, A., & Castañeda, M. B. (1993). College persistence: Structural equations modeling test of an integrated model of student retention. *The Journal of Higher Education*, *64*(2), 123-139.

Cabrera, A. F., Stampen, J. O., & Hansen, W. L. (1990). Exploring the effects of ability to pay on persistence in college. *Review of Higher Education*, *13*(3), 303-336.

Camara, W.J., Echternacht, G. (2000). *The SAT I and high school grades: Utility in predicting success in college*. New York, NY: College Entrance Examination Board.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate behavioral research, 1*(2), 245-276.

Chemers, M. M., Hu, L., & Garcia, B. F. (2001). Academic self-efficacy and first year college student performance and adjustment. *Journal of Educational Psychology, 93,* 55-64.

Cheryan, S., Drury, B. J., & Vichayapai, M. (2013). Enduring influence of stereotypical computer science role models on women's academic aspirations. *Psychology of Women Quarterly, 37*(1), 72-79.

Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? *Social Psychological and Personality Science, 2*(6), 656-664.

Choy, S. P., Horn, L. J., Nuñez, A. M., & Chen, X. (2000). Transition to college: What helps at risk students and students whose parents did not attend college. In A. F. Cabrera, & S. M. La Nasa (Eds.), *Understanding the college choice of disadvantaged students* (pp. 45-63). San Francisco: Jossey-Bass Publishers.

Chubin, D.E., DePass, A.L., & Blockus, L. (Eds.) (2010). *Understanding interventions that broaden participation in research careers.* Summary of a Conference in Bethesda, MD, May 7-9, 2009. Bethesda, MD: American Society for Cell Biology.

Clotfelter, C. T. (1991). Financial aid and public policy. In C. T. Clotfelter, R. G. Ehrenberg, M. Getz, & J. J. Siegfried (Eds.), *Economic challenges in higher education.* Chicago: University of Chicago Press.

Coelli, M. B. (2011). Parental job loss and the education enrolment of youth. *Labour Economics, 18*, 25–35.

Cole, D., & Espinoza, A. (2008). Examining the academic success of Latino students in science, technology, engineering, and mathematics (STEM) majors. *Journal of College Student Development*, *49*(4), 285–300.

Committee on Institutional Cooperation. (2008). *Collective impact:50 years of strategic collaboration.*Retrieved from http://www.cic.net/docs/default-source/news-pub/50thanniversary.pdf

Cook, T.D. & Campbell, D.T. (1979). *Quasi-experimentation: Design and analysis issues for field settings.* Boston, MA: Houghton Mifflin.

Cortina, J.M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*, 98-104.

Davis, D. J. (2005). *The summer research opportunity program: Mentorship and the socialization of underrepresented minorities into the professoriate.* Unpublished Doctoral Dissertation, University of Illinois, Urbana-Champaign.

DeBerard, M. S., Spielmans, G. I., & Julka, D. C. (2004). Predictors of academic achievement and retention among college freshman: A longitudinal study. *College Student Journal, 38*, 66–80.

DePass, A.L., & Chubin, D.E. (Eds.) (2009). *Understanding interventions that encourage minorities to pursue research careers: Building a community of research and practice.* Summary of a Conference in Atlanta, GA, May 2-4, 2008. Bethesda, MD: American Society for Cell Biology.

DeVellis, R.F. (2011). *Scale development: Theory and applications.* Los Angeles, CA: Sage.

Dennis, J.M., Phinney, J.S., & Chuateco, L.I. (2005). The role of motivation, parental support and peer support in the academic success of ethnic minority first-generation college students. *Journal of College Student Development, 46*(3), 223-236.

DesJardins, S. L., & Lindsay, N. K. (2008). Adding a statistical wrench to the "toolbox". *Research in Higher Education*, *49*(2), 172-179.

DesJardins, S. L., McCall, B. P., Ahlburg, D. A., & Moye, M. J. (2002). Adding a timing light to the "tool box". *Research in Higher Education*, *43*(1), 83-114.

Desrochers , D. M. , & Wellman , J. V. (2011 *). Trends in college spending 1999–2009: Where does the money come from? Where does it go? What does it buy?* Washington, DC : Delta Project on Postsecondary Education Costs, Productivity, and Accountability . Retrieved from http://www.deltacostproject.org

Donaldson, S.I. (2007). *Program theory-driven evaluation science: Strategies and applications.* Mahwah, NJ: Erlbaum.

Dynarski, S. (2003). Does aid matter? Measuring the effect of student aid on college attendance and completion. *American Economic Review, 93,* 279-288.

Dynarski, S., & Scott-Clayton, J. (2013). *Financial aid policy: Lessons from research* (No. w18710). National Bureau of Economic Research.

Eatman, T.K. (2002). *Becoming a member of the research community in academe: Determinants of postbaccalaureate success for traditionally underrepresented students*. Unpublished Doctoral Dissertation, University of Illinois, Urbana-Champaign.

Fagen, A. P., & Labov, J.B. (2007). Understanding interventions that encourage minorities to pursue research careers: Major questions and appropriate methods. *CBE Life Science Education, 6*(3), 187-189.

Feldman, G. S. (1999). *Self efficacy and outcome expectations in successful student development:A multi-ethnic study of the college transition*. Unpublished doctoral dissertation, Northwestern University.

Ferguson, R. (1998). Can schools narrow the Black-White test score gap? In C. Jencks & M. Phillips(Eds.)*, The Black White test score gap* (pp. 318-374). Washington, DC: Brookings Institution.

Flanagan, C. A., & Eccles, J. A. (1993). Changes in parents' work status and adolescents' adjustment at school. *Child Development*, *64,* 246–257.

Fleming, J. (2002). Who will succeed in college? When the SAT predicts Black students' performance. *Review of Higher Education, 25*(3), 281–296.

Floyd, C. (1996). Achieving despite the odds: A study of resilience among a group of African American high school students. *Journal of Negro Education, 65*, 181- 189.

Foertsch, J., Alexander, B. B., & Penberthy, D. (2000). Summer research opportunity programs (SROPs) for minority undergraduates: A longitudinal study of program outcomes, 1986-1996. *CUR Quarterly, 20*(3), 114-119.

George, Y. S., Neale, D. S., Van Horne, V., & Malcolm, S. M. (2001). *In pursuit of a diverse science,technology, engineering, and mathematics workforce: Recommended research priorities to enhance participation by underrepresented minorities.* Washington, DC: American Association for the Advancement of Science.

Gladieux, L. E. (1983). The issue of equity in college finance. *Proceedings of the Academy of Political Science, 35*(2, The Crisis in Higher Education), 72-83.

Gonzalez, R. & Padilla, A. (1997). The academic resilience of Mexican ethnic and academic identities 13 American high school students. *Hispanic Journal of Behavioral Sciences, 19*(3), 301-317.

Goode, W. J. (1960). A theory of role strain. *American Sociological Review*, *25,* 483–496.

Gose, B., & Selingo, J. (2001, October 26). The SAT's greatest test. *Chronicle of Higher Education, 68*, pp. A10-A15.

Graham, A, & Husted, T. (1993). Understanding state variation in SAT scores. *Economics of Education 12*(3), 197-202.

Grandy, J. (1998). Persistence in science of high-ability minority students. *Journal of Higher Education 69*(6), 589–620.

Greene, J. P., & Forster, G. (2003). *Public High School Graduation and College Readiness Rates in the United States*. New York: Center for Civic Innovation, Manhattan Institute.

Greene, J. P., & Winters, M. A. (2005). *Public high school graduation and college-readiness rates:1991–2002*. New York: Center for Civic Innovation, Manhattan Institute.

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review, 29*(6), 911-922.

Hacker, A. (1992). *Two nations: Black and White, separate, hostile, unequal.* New York, NY: Ballantine

Hansen, W. L. (1983). Impact of student financial aid on access. *Proceedings of the Academy of Political Science, 35*(2), The Crisis in Higher Education, 84-96.

Hearn, J. C. (1988). Determinants of postsecondary education attendance: Some implications of alternative specifications of enrollment. *Educational Evaluation and Policy Analysis, 10*(2), 171-q185.

Hearn, J. C. (1998). The growing loan orientation in federal financial-aid policy: A historical perspective. In R. Fossey & M. Bateman (Eds.), Condemning students to debt: College loans and public policy (pp. 47-75). New York: Teachers College Press.

Heller, D. E. (1997). *Access to public higher education. 1976 to 1994*. Unpublished doctoral dissertation, Harvard University, Cambridge.

Heller, D. E. (1999). The effects of tuition and state financial aid on public college enrollment. *Review of Higher Education, 23(*1), 65-89.

Heller, D. E. (Ed.). (2002). *Condition of access: Higher education for lower income students*. Westport, CN: American Council on Education/Praeger.

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, Engineering and mathematics.* Washington, DC: American Association of University Women.

Horn, L. & Kojaku, L.W. (2001). *High school academic curriculum and the persistence path through college*. Washington, DC: National Center for Education for Statistic.

Horn, L., and Nuñez, A.M. (2000*). Mapping the road to college: First-generation students' math track, planning strategies, and context of support (NCES 2000–153)*. U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.

Hout, M. (2012). Social and economic returns to college education in the United States. *Annual Review of Sociology, 38*, 379-400.

Hoyle, R. H., Harris, M. J., & Judd, C. M. (2002). *Research methods in social relations*. Belmont, CA: Wadsworth.

Hunter, A. B., Laursen, S. L., & Seymour, E. (2006). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education, 91*, 36–74.

Jaccard, J. & Turrisi, R. (2003). *Interaction effects in multiple regression*. Chicago, IL: Sage Publications.

Jackson, G. A. (1989). *Responses of black, Hispanic, and white students to financial aid: College entry among recent high school graduates*. College Park, MD: National Center for Postsecondary Governance & Finance, University of Maryland.

Jackson, G.A. (1990). Financial aid, college entry, and affirmative action. *American Journal of Education*, *98*(4), 523-551.

James, S.A. (1994). John henryism and the health of African-Americans. *Culture Medicine and Psychiatry, 18,* 163-182.

James, S. A., Hartnett, S. A., & Kalsbeek, W. D. (1983). John Henryism and blood pressure differences among black men. *Journal of Behavioral Medicine, 6*, 259-278.

James, S. A., LaCroix, A. Z., Kleinbaum, D. G., & Strogatz, D. S. (1984). John Henryism and Blood pressure differences among black men. II. The role of occupational stressors. *Journal of Behavioral Medicine, 7*, 259–275.

James, S. A., Strogatz, D. S., Wing, S. B., & Ramsey, D. L. (1987). Socioeconomic status, John Henryism, and hypertension in blacks and whites. *American Journal of Epidemiology*, *126*(4), 664-673.

Jencks, C., & Phillips, M. (1998). The Black-White test score gap: An introduction. In C. Jencks & M. Phillips (Eds.), *The Black White test score gap* (pp. 1-51). Washington, Jensen, E. L. (1983). Financial aid and educational outcomes: A review. *College and University*, *58*, 287–303.

Johnson, J. M. (2005). *The undergraduate research program experience: An exploratory analysis*. Unpublished doctoral dissertation, University of Michigan.

Johnson, D.R., & Creech, J.C. (1983) Ordinal measures in multiple indicator models: A simulation study of categorization error. *American Sociological Review, 48,* 398-407.

Kaiser, H. F. (1960) The application of electronic computers to factor analysis. *Educational and Psychological Measurement, 20,* 141-151.

Kane, T. J. (1994). College entry by blacks since 1970: The role of college costs, family background, and the returns to education. *The Journal of Political Economy, 102*(5), 878-911.

Kane, T. J. (1999). *The price of admission: Rethinking how Americans pay for college.* Washington, DC: Brookings Institution Press.

Kane, T. J. (2003). *A quasi-experimental estimate of the impact of financial aid on college-going*. Cambridge, MA: National Bureau of Economic Research.

Katkin, W. (2003). The Boyer Commission Report and its impact on undergraduate research. *New Directions for Teaching and Learning, 2003*(93), 19-38.

Kenny, D. A. (2013). *Mediation.* Retrieved from http://davidakenny.net/cm/mediate.htm.

Kenny, R. W. (1998). *Reinventing undergraduate education: A blueprint for America's research universities.* Boyer Commission on Educating Undergraduates in the Research University.

King, J. E. (1996). *The decision to go to college: Attitudes and experiences associated with college attendance among low-income students.* Washington, D.C.: The College Board, 1996.

Kim, J. O., & Mueller, C. W. (1978). *Factor analysis: Statistical methods and practical issues.* Newbury Park: SAGE Publications.

Kirn, W. (2009, July 5). Life liberty and the pursuit of aptitude. *The New York Times*. Retrieved from http://www.nytimes.com/2009/07/05/magazine/05fob-wwln-t.html?pagewanted=all

Lee, V. E., & Burkam, D. T. (2002). *Inequality at the starting gate: Social background differences in achievement as children begin school.* Washington, DC: Economic Policy Institute.

Lefcourt, H. M., Von Baeyer, C. L., Ware, E. E., & Cox, D. J. (1979). The multidimensional-multiattributional causality scale: The development of a goal specific locus of control scale. *Canadian Journal of Behavioural Science*, *11*(4), 286.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. *Journal of Counseling Psychology*, *31*, 356–362.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. *Journal of Counseling Psychology*, *33*, 265–269.

Leslie, L. L., & Brinkman, P. T. (1987). Student price response in Higher Education: The student demand studies. *The Journal of Higher Education*, *58*(2), 181-204.

Leslie, L. L., & Brinkman, P. T. (1988). *The economic value of higher education*. New York: Macmillan.

Leventhal, T., Fauth, R., & Brooks-Gunn, J. (2005). Neighborhood poverty and public policy: A 5-year follow-up of children's educational outcomes in the New York City moving to opportunity demonstration. *Developmental Psychology, 41*, 933-952.

Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): first findings, *Cell Biology Education, 3,* 270-277.

Lopatto, D. (2007). Undergraduate research experiences support science career decisions and active learning. *CBE-Life Sciences Education, 6*(4), 297-306.

Luthar, S.S., & Cicchetti, D. (2000). The construct of resilience: Implications for interventions and social policies. *Development and Psychopathology, 12*, 857-885.

Mallette, B. I., & Cabrera, A. F. (1991). Determinants of withdrawal behavior: An exploratory study. *Research in Higher Education, 32*(2), 179-194.

Manski, C. F., & Wise, D. A. (1983). *College choice in America.* Cambridge, MA: Harvard University Press.

Mark, M.M., Donaldson, S.I. & Campbell, B. (2011). *Social psychology and evaluation.* NY: Gilford.

Mark, M. M., & Henry, G. T. (2004). The mechanisms and outcomes of evaluation influence. *Evaluation, 10*(1), 35-57.

Maton, K. I., Domingo, M. R. S., Stolle-McAllister, K. E., Zimmerman, J. L., & Hrabowski III, F. A. (2009). Enhancing the number of African-Americans who pursue STEM Phds:

Meyerhoff Scholarship Program outcomes, processes, and individual predictors. *Journal of Women and Minorities in Science and Engineering, 15*(1).

Maton, K. I., & Hrabowski III, F. A. (2004). Increasing the number of African American PhDs in the sciences and engineering: A strengths-based approach. *American Psychologist, 59*(6), 547-556.

Maton, K. I., Hrabowski, F. A., & Schmitt, C. L. (2000). African American college students excelling in the sciences: College and postcollege outcomes in the Meyerhoff Scholars Program. *Journal of Research in Science Teaching, 37*(7), 629-654.

Maton, K. I., Pollard, S. A., McDougall Weise, T. V., & Hrabowski, F. A. (2012). Meyerhoff Scholars Program: A strengths based, institution wide approach to increasing diversity in science, technology, engineering, and mathematics. *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine*, *79*(5), 610-623.

McGee, E. O. (2009). *Race, identity, and resilience: Black college students negotiating success in mathematics and engineering.* Unpublished Doctoral Dissertation. Chicago, IL.

McMillan, J. H., & Reed, D. F. (1994). At-risk students and resiliency: Factors contributing to academic success. *Clearing House, 67*, 137−140.

McPherson, M. S., & Schapiro, M. O. (1991). *Keeping college affordable: Government and educational opportunity*. Washington, DC: The Brookings Institution.

McPherson, M. S., & Schapiro, M. O. (1993). Measuring the effects of federal student aid: An assessment of some methodological and empirical problems. In M. McPherson, M. O. Schapiro & G. C. Winston (Eds.), *Paying the Piper* (pp. 187-228). Ann Arbor, MI: The University of Michigan Press.

McPherson, M. S., & Schapiro, M. O. (1998), *The student aid game: Meeting need and rewarding talent in American higher education*. Princeton, NJ: Princeton University Press.

Millet, C. M. (2003). How undergraduate loan debt affects application and enrollment in graduate or first professional school. *The Journal of Higher Education*, *74*(4), 386-427.

Museus, S., Palmer, R. T., Davis, R. J., & Maramba, D. C. (2011). *Racial and ethnic minority students' success in STEM education.* Hoboken, NJ: Jossey-Bass

Musoba, G. D. (2004). Postsecondary encouragement for diverse students: A reexamination of the Twenty-first Century Scholars Program. In C. Teddlie, E. A. Kemper (Series Eds.) & E. P. St. John, (Vol. Ed.) *Readings on equal education: Vol. 19. Public policy and college access* (pp. 153-180). New York: AMS Press.

National Research Council (2007). *Rising above the gathering storm.* Washington, DC: The National Academies Press.

National Research Council (2009). *Rising above the gathering storm two years later: Accelerating progress toward a brighter economic future.* Washington, DC: The National Academies Press.

National Research Council (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics*. Washington, DC: The National Academies Press.

National Action Council for Minorities in Engineering, Inc. (2008). *Confronting the "new" American dilemma – Underrepresented minorities in engineering: A data-based look at diversity.* White Plains, NY: NACME.

National Science Foundation (2013). *Women, minorities and persons with disabilities in science and engineering: 2013.* Arlington, VA: NSF

Neville, H. A., Heppner, P. P., Ji, P., & Thye, R. (2004). The relations among general and race-related stressors and psychoeducational adjustment in black students attending predominantly white institutions. *Journal of Black Studies, 34*, 599-618.

Nora, A., & Cabrera, A. F. (1996). The role of perceptions of prejudice and discrimination on the adjustment of minority students to college. *Journal of Higher Education, 67*(2), 119-148.

Olson, S. and Fagen A. P. (2007).*Understanding Interventions That Encourage Minorities to Pursue Research Careers: Summary of a Workshop*; National Academies Press: Washington, DC.

Orfield, G. (1992). Money, equity, and college access. *Harvard Educational Review, 62*(3), 337-372.

Paulsen, M. B., & St. John, E. P. (2002). Social class and college costs: Examining the financial nexus between college choice and persistence. *Journal of Higher Education, 73*(2), 189-236.

Pender, M., Marcotte, D. E., Domingo, M. R. S., & Maton, K. I. (2010). The STEM pipeline: the role of summer research experience in minority students' Ph. D. aspirations. *Education Policy Analysis Archives*, *18*(30), 1.

Perna, L. W. (2000). Differences in the decision to attend college among African Americans, Hispanics, and Whites. *Journal of Higher Education*, *71*, 117–141.

Perna, L. W. (2006). Studying college choice: A proposed conceptual model. In J. C. Smart (Ed.), *Higher education: Handbook of theory and research* (Vol. 21, pp. 99–157). Dordrecht, NL: Springer.

Purdue University Office of Budget and Fiscal Planning (2012). Comparison of tuition and fees at peer and Big Ten public universities. Retrieved from http://www.purdue.edu/datadigest/peer/pg113.html.

Ramist, L., Lewis, C., and McCamley-Jenkins, L. (1994). *Student group differences in predicting college grades: Sex, language, and ethnic group* (College Board Report Number 93-1; ETS RR-94-27). New York: College Board.

Reyes, E. A. (2002). *Extended family support as a protective factor among college students: An exploratory multi-ethnic study*. Unpublished doctoral dissertation, Northwestern University.

Robbins, S. B., Lauver, K., Le, H., Davis, D., Langley, R., & Carlstrom, A. (2004). Do Psychosocial and Study Skill Factors Predict College Outcomes? A Meta-Analysis. *Psychological Bulletin, 130*(2), 261-288.

Rose, H., & Betts, J. R. (2001). *Math matters: The links between high school curriculum, college graduation, and earnings*. San Francisco: Public Policy Institute.

Rosenbaum, J. E., & Popkin, S. J. (1991). Employment and earnings of low-income blacks who move to middle-class suburbs. In C. Jencks & P. E. Peterson (Eds.), *The urban underclass*.Washington, DC: The Brookings Institution.

Russell, S. H., Hancock, M. P., & McCullough, J. (2006). *Evaluation of NSF support for Undergraduate research opportunities: Follow-up survey of undergraduate NSF program participants.* Unpublished manuscript, SRI International, Menlo Park, CA.

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science, 316*(5824), 548-549.

Rutter, M. (1987). Psychosocial resilience and protective mechanisms. *American Journal of Orthopsychiatry, 57*, 316-331.

Salins, P.D. (2008, November 18). The test passes, colleges fail. *The New York Times.* Retrieved from http://www.nytimes.com/2008/11/18/opinion/18salins.html

Sanders, M. G. (1998). The effects of school, family, and community support on the academic achievement of African American adolescents. *Urban Education, 33*(3), 385-409.

Schwartz, J. B. (1985). Student financial aid and the college enrollment decision: The effects of public and private grants and interest subsidies. *Economics of Education Review, 4*(2), 129-144.

Schwartz, J. B. (1986). Wealth neutrality in higher education: The effects of student grants. *Economics of Education Review* 5(2),107–17.

Sedlacek, W. E. (2004). *Beyond the big test: Noncognitive assessment in higher education*. San Francisco: Jossey-Bass.

Shiraishi, Y. (2000). *Attributional patterns and adjustment in the college transition: A cross-Cultural study*. Unpublished doctoral dissertation, Northwestern University.

Shadish, W.R., Cook, T.D., & Campbell, D.T. (2001). *Experimental and quasi-experimental design for generalized causal inference.* NY: Houghton Mifflin.

Smedley, B. D., Myers, H. F., & Harrell, S. P. (1993). Minority-status stresses and the college adjustment of ethnic minority freshmen. *Journal of Higher Education, 64*, 434-52.

SRI International (n.d.). *Evaluating the benefits of undergraduate research opportunities for NSF.* Retrieved from website http://csted.sri.com/projects/evaluating-benefits-undergraduate-research-opportunities-uro-nsf

Stage, F. & Wells, R. (in press). New perspectives on critical quantitative inquiry. New Directions for Institutional Research San Francisco, CA: Jossey-Bass.

Stinebrickner, R., & Stinebrickner, T. R. (2003). Understanding educational outcomes of students from low-income families. *Journal of Human Resources,38*(3), 591-617.

St. John, E. P. (1990). Price response in enrollment decisions: An analysis of the High School and Beyond Sophomore cohort. *Research in Higher Education, 31*(2), 161-176.

St. John, E. P. (1991). What really influences minority attendance? Sequential analysis of the high school and beyond sophomore cohort. *Research in Higher Education, 32*(2), 141-158.

St. John, E. P. (2003). *Refinancing the college dream: Access, equal opportunity, and justice for taxpayers.* Baltimore, MD: Johns Hopkins University Press.

St. John, E. P. (2004). The impact of financial aid guarantees on enrollment and persistence: Evidence from research on Indiana's Twenty-first Century Scholars and Washington State Achievers programs. In D. E. Heller & P. Marin (Eds.), *State merit scholarship programs and racial inequality* (pp. 123-140). Cambridge, MA: The Civil Rights Project at Harvard University.

St. John, E. P. (2006). *Education and the public interest: School reform, public finance, and access to higher education.* Dordrecht, The Netherlands: Springer.

St. John, E.P. (2011). Critical analysis of merit assumptions in higher education. In P.J. Bowman & E.P. St. John (Eds.), *Diversity, merit, and higher education: Readings on equal education*. New York, NY: AMS Press, Inc.

St. John, E. P., & Chung, A. S. (2006). Enrollment. In E. P. St. John (Ed.) *Education and the public interest* (pp.163-192). AA, Dordrecht: Springer.

St. John, E.P., Fisher, A. S., Williams, K. L. & Daun-Barnett, N. (2008). *Educational opportunity in Indiana: A study of the twenty-first century scholars program.* Lumina Foundation for Education: Indianapolis, IN.

St. John, E. P., Hu, S., & Fisher, A. S. (2011). *Breaking through the access barrier: Academic capital formation informing public policy.* New York: Routledge.

St. John, E. P., & Musoba, G. D. (2006). Academic access. In E. P. St. John (Ed.), *Education and the public interest* (pp 57-82). AA Dordrecht: Springer.

St. John, E. P., & Musoba, G. D. (2010). *Pathways to academic success: Expanding opportunity for underrepresented students.* New York: Routledge.

St John, E. P., Musoba, G. D., & Simmons, A. B. (2003). Keeping the promise: The impact of Indiana's twenty-first century scholars program. *The Review of Higher Education*, *27*(1), 103-123.

St. John, E. P., Musoba, G. D., Simmons, A. B., & Chung, C. G. (2002). *Meeting the access challenge:Indiana's twenty-first century scholars program.* New Agenda Series, vol. 4, no. 4. Indianapolis: Lumina Foundation for Education.

St. John, E. P., Musoba, G. D., Simmons, A., Chung, C. G., Schmit, J., & Peng, C. Y. J. (2004). Meeting the access challenge: An examination of Indiana's Twenty-first Century Scholars Program. *Research in Higher Education, 45*(8), 829-871.

St. John, E. P., & Noell, J. (1989). The effects of student financial aid on access to higher education: An analysis of progress with special consideration of minority enrollment. *Research in Higher Education*, *30*(6), 563-581.

St. John, E. P., Paulsen, M. B., & Starkey, J. B. (1996). The nexus between college choice and persistence. *Research in Higher Education,37*, 175-220.

Struthers, C. W., Perry, R. P., & Menec, V. H. (2000). An examination of the relationship among academic stress, coping, motivation, and performance in college. *Research in Higher Education 41*(5), 581–592.

Supiano, B. (2009, August 25). SAT scores down slightly as number of test takers rises. *Chronicle of Higher Education*. Retrieved from http://chronicle.com/article/SAT-Scores-Down-Slightly-as/48166/

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition.* Chicago: University of Chicago Press.

Tusaie, K., & Dyer, J. (2004). Resilience: A historical review of the construct. *Holistic Nursing Practice, 18*, 3–8.

UMBC Meyerhoff Scholars Program (n.d.). *Program Results: Meyerhoff by the numbers.* Retrieved from website http://umbc.edu/meyerhoff/program_results.html

U.S. Department of Education (2002). *National Evaluation of GEAR UP A Summary of the First Two Years*, Washington, DC: U.S. Government Printing Office.

U.S. Department of Education. (n.d.). *Federal student aid.* Retrieved from http://studentaid.ed.gov/types/grants-scholarships.

White House (n.d.). Educate to innovate. Retrieved from http://www.whitehouse.gov/issues/education/k-12/educate-innovate

Yauch, C.A., (October, 2007). The impact of undergraduate research experiences on graduate school pursuit by industrial engineers. Unpublished paper presented at The 37th annual ASEE/IEE Frontiers in education conference, Milwaukee, WI.

Young, D. M., Rudman, L. A., Buettner, H. M., & McLean, M. C. (2013). The influence of female role models on women's implicit science cognitions. *Psychology of Women Quarterly, 37(3),* 283-292.

Zhe, J., Doverspike, D., Zhao, J., Lam, P., & Menzemer, C. (2010). High school bridge program: A multidisciplinary STEM research program. *Journal of STEM Education: Innovations and Research*, *11*(1), 61-68.

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal-setting. *American Educational Research Journal*, *29*, 663-676.

Zumbo, B.D., & Zimmerman, D.W. (1993). Is the selection of statistical methods governed by level of measurement? *Canadian Psychology*, *34*, 390-400.

Zwick, R., & Sklar, J. C. (2005). Predicting college grades and degree completion using high school grades and SAT scores: The role of student ethnicity and first language. *American Educational Research Journal*, *42*(3), 439-464.