Organizational Support, Satisfaction, and STEM Research Career Plans in Pipeline Interventions: A Strengths-Based Approach among Underrepresented Students

by

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DEDICATION

I dedicate this dissertation to my ancestors and descendants of the Bailey, Broadnax, Carr, Dennis, Ford, Johnson, Eugene, Lee, Polk, Ragland, Roby, Sanders, Scott, Thomas, and White families.

Ecclesiastes 3, King James Version (KJV)

To everything there is a season, and a time to every purpose under the heaven: A time to be born, and a time to die; a time to plant, and a time to pluck up that which is planted; A time to kill, and a time to heal; a time to break down, and a time to build up; A time to weep, and a time to laugh; a time to mourn, and a time to dance; A time to cast away stones, and a time to gather stones together; a time to embrace, and a time to refrain from embracing; A time to get, and a time to lose; a time to keep, and a time to cast away; A time to rend, and a time to sew; a time to keep silence, and a time to speak; A time to love, and a time to hate; a time of war, and a time of peace. What profit hath he that worketh in that wherein he laboureth? I have seen the travail, which God hath given to the sons of men to be exercised in it. He hath made everything beautiful in his time: also he hath set the world in their heart, so that no man can find out the work that God maketh from the beginning to the end.

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DEFINITION OF KEY TERMS

1. Comprehensive Research Opportunity Program: Faculty-mentored research experiences organized with multiple program components to provide strong social capital including multiple resources, supportive norms among committed program staff, and supportive program habitat characterized by interpersonal trust among mentors, staff, and participants.

2. Exemplary Pipeline Intervention Program: Program that has demonstrated efficacy and benefits for participants.

3. Intensive Summer Interventions: Short-term interventions that occur for a period of time during the summer months.

4. Longer-Term Interventions: More extensive pipeline interventions that occur for one full year or more.

5. Social Capital: Characteristics of institutions, organizations, or programmatic networks that systematically provide a bundle of assets, resources, supportive norms, and informational relationships.

6. Strong Pipeline Interventions: Comprehensive interventions with multiple programmatic components that are strategically organized to have particular efficacy for underrepresented students who must overcome systematic barriers to successful outcomes at critical stages in the higher education and career pipeline.

7. Underrepresented (UR): Racial and ethnic minorities, women, and low income student populations that are underrepresented in science, technology, engineering, and mathematics (STEM) relative to their numbers in general.

8. Traditionally Underrepresented Minority (URM): Students self-identified as Black/African American, Hispanic/Latino (a), Alaskan, or American Indian.

ABSTRACT

Organizational Support, Satisfaction, and STEM Research Career Plans in Pipeline Interventions: A Strengths-Based Approach among Underrepresented Students

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This policy-relevant study provides new insight into the *social organization* of pipeline interventions for underrepresented (UR) students and how strong *organizational support* can help to explain successful Science, Technology, Engineering, and Mathematics (STEM) outcomes. Guided by the strengths-based role stress and adaptation literature, the study focused on two major Research Aims: (1) to develop *reliable and valid measures* of strong *formal* and *informal* organizational support that are useful for research on UR students in pipeline interventions; and (2) to explore how strong formal and informal organizational support measures may help to *explain* overall program satisfaction and successful STEM research career plans among UR students. To investigate several related questions, multivariate analyses were conducted on panel survey data from UR students in a *strong* pipeline program with multiple program components and UR students in other pipeline interventions with fewer *formal* program components. With respect to the Research Aim 1, factor analyses clearly supported the *reliability and validity* of *both* formal and informal organizational support scales. This NIH-NIGMS supported study revealed that UR students in a nationally recognized *Summer Research Opportunity Program* designed with multiple components had higher scores on the strong formal

organizational support scale items. Moreover, UR students with higher formal organizational support also had significantly higher informal support from program peers than from either faculty mentors or program staff sources. Overall, findings on Research Aim 2 were less clear as STEM major emerged as the strongest predictor of STEM research career plans. However, there were: (1) a clear relationship between strong formal organizational support and program satisfaction, and (2) a significant but modest relationship between program satisfaction and STEM research career plans. Racial/ethnic and gender comparisons revealed some interesting directions for future policy-relevant research and practice to broaden participation in STEM research careers. The relevance of study findings was also discussed with an emphasis on refining a strengths-based model of successful STEM outcomes, guiding future research as well as implications for program practice and policy.

CHAPTER I

INTRODUCTION

As we move further into the twenty-first century, there is a growing national call for effective pipeline interventions to broaden the participation of underrepresented (UR) students in science, technology, engineering, and mathematics (STEM) graduate studies and careers in the United States (Bowman & St. John, 2011; Chubin, DePass, & Blockus, 2009; Chubin & DePass, 2012; DePass & Chubin, 2008; Olson & Fagen, 2007). Policy-relevant pipeline interventions at the K-12, undergraduate, graduate, and postdoctoral levels have been organized in an attempt to expand the participation of racial and ethnic minorities, women, and low-income students in STEM careers. The policy significance of this national call was further clarified by the Committee on Prospering in the Global Economy of the 21st Century in its 2005 report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future*, for the National Academies. This report concluded that "without a renewed effort to bolster the foundations of our competiveness, we can expect to lose our privileged position" (p. 10). Their 2010 *Gathering Storm* follow-up report concluded that America's relative global position had worsened and that the only promising avenue for sustainable U.S. prosperity was through innovation (Members of the 2005 "Rising Above the Gathering Storm" Committee, 2010). This report noted that the U.S. ranks only 20th in high school completion rates, 16th in college completion rates, and even worse in mathematics and science education.

Based on these rankings, several European and Asian countries appear more effective than the United States in promoting STEM primary, secondary, and higher education, advanced graduate studies, and research careers (Altbach & Peterson, 2008; Goastellec, 2008; Lin, 2008). Moreover, the global demand for STEM workers with diverse backgrounds has resulted in some STEM workers leaving the U.S. for other countries, which also has contributed to a domestic "brain drain" of STEM talent in the U.S. As noted in a recent report by the National Academies, *Expanding Underrepresented Minority Participation*: *America's Science and Technology Talent at the Cross Roads*,

> For many years, the nation relied on a [STEM] workforce that was predominantly male and overwhelmingly White and Asian. We have seen gains for women in some fields and an increasing reliance on international students in others. Non-U.S. citizens, particularly those from China and India, have accounted for almost all the growth in STEM doctorate awards and in some engineering fields comprise the majority of new doctorates. Yet, we are coming to understand that relying on non-U.S. citizens for our science and engineering workforce is an increasingly uncertain proposition. (National Academies, 2011, p. 2–3)

In addition to the National Academies, organizations such as the National Action Council for Minorities in Engineering; the American Association for the Advancement of Science (AAAS); the Congressional Commission on the Advancement of Women and Minorities in Science; Engineering and Technology Development (CAWMSET); and the National Center for Education Statistics (NCES) have expressed concern with the highly-skilled STEM talent shortage in the United States. While this shortage presents opportunity gaps for the most increasingly disenfranchised populations, the nation continues to subscribe to the quick-fix

solution of outsourcing highly-skilled STEM jobs to other nations. These trends suggest a vital concern about lost STEM talent and a related need to increase not only the number of UR students in the U.S. who pursue STEM fields, but also the diversity of viewpoints and strategies that can be applied in solving today's scientific problems.

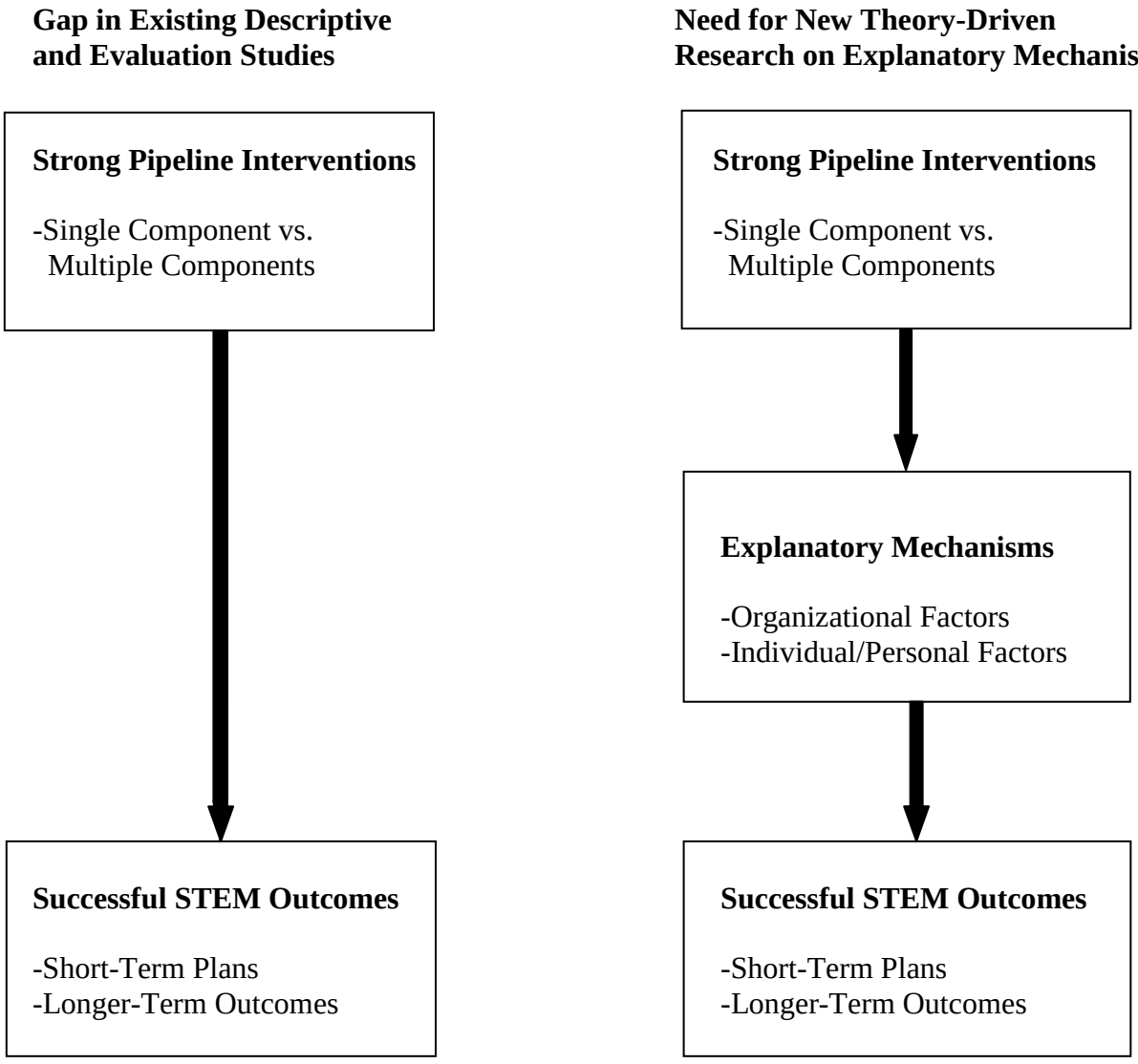
Pipeline Intervention Research: The Significance of Theory-Driven Studies

In response to the national call for effective STEM pipeline interventions, there has been a growing amount of related research with clear policy relevance. In 2007 the U.S. Congress passed the America COMPETES Act, which clarified the need for research to:

> …explore the role of diversity in the STEM workforce and its value in keeping America innovative and competitive, analyze the rate of change and the challenges the nation currently faces in developing a strong and diverse workforce, and identify best practices and characteristics of these practices that make them effective and sustainable. (National Academies, 2011, p. 2)

As suggested in Figure 1.1**,** most pipeline intervention research has focused on either: (1) descriptive analyses of exemplary STEM pipeline interventions, with emphasis on financial aid and/or academic or instructional components (e.g., Pender, Marcotte, Sto. Domingo, & Maton, 2010; Williams, 2014); or (2) formative and summative evaluations, with emphasis on implementation issues or program outcomes (e.g., Chubin, DePass, & Blockus, 2009; DePass & Chubin, 2008; Olson & Fagen, 2007). For more than 30 years, higher education studies have described the provision of financial aid as a major component of effective pipeline interventions, and have evaluated its benefits for program participants (e.g., Ishitani & DesJardins, 2002; St. John, 1991, 2008; Williams, 2014). In addition, a growing number of studies have begun to focus on the critical importance of curricula and instructional components of pipeline interventions to

Figure 1.1: Strong Pipeline Interventions, Explanatory Mechanisms, and STEM Outcomes



successful student outcomes (e.g., Fullilove & Triesman, 1990; Villarejo & Barlow, 2007; Tyson et al., 2007). To be sure, both types of studies have important policy relevance.

However, there is a pressing need for theory-driven research on more comprehensive pipeline interventions (Bowman & St. John, 2011; Chubin, DePass, & Blockus, 2009; Chubin & DePass, 2012; DePass & Chubin, 2008; Olson & Fagen, 2007). A major gap in existing higher education literature is an understanding of the underlying mechanisms that cause pipeline interventions to be effective, and why some participants benefit more than others. In other words, we cannot yet fully explain successful intervention outcomes such as STEM plans and higher education and career success.

Additional studies are needed to clarify the organizational and individual mechanisms that are involved. Some evidence suggests that "strong" pipeline interventions with multiple components are especially effective for promoting successful outcomes among UR students faced with systematic barriers (e.g., Maton & Hrabowski, 2004). This effectiveness of strong pipeline programs may well be a function of formal and informal organizational support mechanisms. In addition, a growing number of other studies suggest that individual/personal strengths may also contribute to successful STEM outcomes (e.g., Bowman, 2006, 2011a, 2013).

There is increasing support for additional theory-driven research to further understand and improve the efficacy of strong pipeline interventions for talented students with restricted educational opportunities. Governmental agencies such as the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Department of Education, along with foundations and non-profits, currently support a growing body of research in this area (Bowman & St. John, 2011; Chubin, DePass, & Blockus, 2009; Chubin & DePass, 2012; DePass & Chubin, 2008; Olson & Fagen, 2007).

Strong Pipeline Interventions: The Significance of Multiple Components

There are growing numbers of pre-K to career pipeline interventions that are designed to improve college readiness among UR students and better prepare them for advanced degrees and STEM careers (Carreathers, Beekmann, Coatie, & Nelson, 1996; Landis, 1985; Maton, Hrabowski, & Schmitt, 2000; Shay, 2000; Thomas, 1985, 1992). Although there are many promising models, it is becoming increasingly clear that we must move beyond single-component strategies (only financial aid, academic skills development, higher education promotion, career development, expert mentoring, or personal development) toward more comprehensive and multi-component interventions (Bowman & St. John, 2011; Trent & St. John, 2008; Hrabowski, Maton, & Greif, 1998; Hrabowski, Maton, Greene, & Greif, 2002).

Several descriptive and evaluation studies suggest that strong pipeline interventions contain multiple components and are formally structured or organized to be comprehensive. Specifically, there are three main categories of strong interventions: philanthropic (e.g., Meyerhoff Scholars Program, Gates Millennium Scholars Program), federal/governmental (e.g., National Science Foundation – Louis Stokes Alliances for Minority Participation), and consortia (e.g., Committee on Institutional Cooperation – Summer Research Opportunity Program).

STEM pipeline studies reviewed by Maton & Hrabowski (2004) suggest that four sets of organizational factors appear necessary to promote UR students' success: (1) academic and social integration, (2) knowledge and skill development, (3) support and motivation, and (4) monitoring and advising. The especially comprehensive Meyerhoff Scholars Program, guided by a strengths-based approach, was organized around fourteen core components: financial aid, recruitment, summer bridge, study groups, program values, program community, personal advising and counseling, tutoring, summer research internships, faculty involvement,

administrative involvement, mentors, community service, and family involvement (e.g., Hrabowski, Maton, & Greif, 1998; Hrabowski, Maton, Greene, & Greif, 2002; Maton & Hrabowski, 2004; Maton, Pollard, Weise, & Hrabowski, 2012). An examination of the components within the Gates Millennium Scholars Program, which has a strong focus on social capital elements, found that personal resources, assets, and strengths within the UR students themselves were also critical to explaining their successful outcomes (Trent & St. John, 2008).

Comprehensive Research Opportunity Programs

Comprehensive Research Opportunity Programs (ROPs) are faculty-mentored research experiences organized with multiple program components to provide stronger social capital including multiple resources, supportive norms among committed program staff, and a supportive program habitat characterized by interpersonal trust among mentors, staff, and participants. Comprehensive programs are increasingly recognized as having an especially high impact on UR students faced with systematic barriers (Cole, 1995; Kuh et al., 1991; Millspaugh & Millenbah, 2004; Randall, Wilbur, & Burkholder, 2004; Thompson, McNeill, Sherwood, & Starck, 2001). Research on strong ROPs with multiple components would help to clarify how social capital at the program level may be linked to formal and informal organizational support experiences that promote success among UR students.

Comprehensive ROPs include short-term and intensive summer interventions (Aguirre, 1993; Davis, 2006; Eatman, 2002; Foertsch et al., 1997, 2000; Gaffney, 1993; Johnson, 2005; Vance, 1993) as well as longer-term mentored research opportunities of one year or more (Hunter, Laursen, & Seymour, 2007; Seymour, 2001). Regardless of duration, a growing number of these interventions provide participants with access to appropriate research facilities, faculty mentors, and multiple forms of formal organizational support, including financial aid and an

array of enrichment activities. A few qualitative studies suggest that the strongest programs also provide informal organizational support from multiple sources, such as faculty mentors, staff, and peers, that contribute to successful outcomes (e.g., Davis, 2006; Johnson, 2005). For example, the NIH-National Institute for General Medicine Sciences (NIGMS) has developed a bold new initiative to study exemplary pipeline interventions that promote research careers among talented participants from underrepresented groups based on three core assumptions regarding strong programs and successful outcomes. When participants are provided the opportunity to engage in state-of-the-art research under faculty mentorship, in appropriate facilities, and accompanied by multiple sources of program support: (1) their motivation to pursue advanced graduate studies and research careers is strengthened; (2) once focused, they also will show improved academic performance and research career competencies; and (3) subsequently, they will be more likely to actually enter advanced graduate studies and succeed in scientific research careers.

Explanatory Mechanisms: Organizational and Individual/Personal Factors

In order to explain successful outcomes and as illustrated in Figure 1.1, theory-driven studies need to further clarify both organizational and individual factors within exemplary pipeline intervention settings. Although strengths-based research is still sparse, an emerging literature points to the importance of organizational mechanisms such as a supportive environment and positive relationships with mentors, staff and peers (e.g., Maton et al., 2000; Maton et al., 2012). Successful programs provide access to appropriate facilities, financial aid, and instructional resources, as well as strong organizational support, formal resources, enrichment activities, and informal support from others (Maton et al., 2000; Maton et al., 2012; Trent & St. John, 2008).

In addition to organizational factors, related studies have focused on individual and personal mechanisms with a particular emphasis on self-efficacy and identity (e.g., Bowman, 2011a; Chemers et al., 2011; Eccles, 2011; Woodcock, Hernandez, Estrada, & Shultz, 2012). Several scholars have suggested that more culturally responsive research is needed to consider the role of the adaptive strengths that UR students often bring to STEM intervention settings, such as personal resiliency, extended family support, and community engagement orientations (Bowman, 2011a, 2013; Hrabowski et al., 1998; Hrabowski et al., 2002; Maton & Hrabowski, 2004; Hamilton et al., 2006). In general, studies on both organizational and individual factors suggest that supportive interventions with multiple components will strengthen successful STEM-related outcomes.

STEM Outcomes: Short-Term and Long-Term Benefits

Evaluation has begun to identify exemplary pipeline interventions that show especially strong efficacy and benefits for participants as depicted in Figure 1.1 (e.g., Chubin, DePass, & Blockus, 2009; DePass & Chubin, 2008; Olson & Fagen, 2007; Trent & St. John, 2008). However, there is a growing interest in better understanding why some participants benefit more from formal intervention activities than do others. The most rigorous outcome evaluation studies of pipeline interventions clearly show greater average benefits for intervention participants compared to control groups, but do not adequately explain differential benefits among individuals within the intervention group (e.g., Bowman, 2013; Bowman & St. John, 2011). A unique collaboration among NIH, NSF, the AAAS, and other scientific agencies is underway to provide additional insight into these factors (Chubin, DePass, & Blockus, 2009; DePass & Chubin, 2008; Olson & Fagen, 2007).

Participants in successful interventions are more often satisfied with their overall experiences, and show benefits related to both short-term outcomes, such as educational and career plans, and longer-term outcomes, such as successful educational and career behaviors (Carter, Mandell, & Maton, 2009; Hrabowski & Maton, 1995; Maton et al., 2009; Maton, Hrabowski, & Schmitt, 2000). The impact of pipeline interventions on longer-term educational and career success remains the primary policy-relevant target in outcome evaluation studies. However, short-term STEM educational and career plans also are significant to both policy and theory. For example, interventions among UR undergraduates that increase short-term plans for STEM graduate study and research careers also have significance for STEM persistence.

Evidence supporting the Theory of Planned Behavior also shows a very strong empirical link between short-term behavioral plans or intentions and longer-term behavioral outcomes (Ajzen, 1991; Ajzen & Fishbein, 1973; Ajzen & Madden, 1986). Pipeline studies that focus on short-term STEM plans immediately following interventions provide a theory-driven basis for related longitudinal studies on longer-term success. Such longitudinal analyses of the relationships between STEM plans and behavioral outcomes can further clarify causal mechanisms. Therefore, among UR undergraduates, STEM research career plans can be conceptualized as a short-term behavioral intention with longer-term implications for STEM persistence and success. According to the Theory of Planned Behavior, intentions or plans represent a critical link between students' STEM beliefs and their longer-term behavioral outcomes. The Theory of Planned Behavior further clarifies how STEM attitudes and research career plans, together with perceptions of behavioral control, account for considerable variance in longer-term STEM outcomes (Ajzen, 1991).

The Present Study: Conceptual Framework and Contributions

The present study develops a comprehensive approach based on social psychological and role stress and adaptation literature in order to explore: (1) the social organization of strong pipeline interventions and (2) the relationship between strong organizational support and successful STEM outcomes among UR student participants (see Figure 1.1). The focus is on participants who applied to a set of Summer Research Opportunity Program (SROP) interventions for undergraduates coordinated by the Committee on Institutional Cooperation (CIC), an academic consortium of the university systems in the Big Ten Conference and the University of Chicago. CIC institutions confer over 15% of all Ph.D. degrees awarded nationally, and more than 20% in some STEM fields. Since 1986, SROP has provided over 11,819 research experiences for talented students, more than 3,000 of whom have pursued graduate studies (Zepeda & Farber, 2010). Coordinated by a central office, the SROP activities on CIC campuses are intentionally and formally designed to provide strong pipeline interventions with multiple components. In addition to financial aid, CIC-SROP provides a formal hands-on research experience supervised by a faculty mentor, regularly scheduled instructional workshops, research presentations, and other formal and informal support activities. On each campus, CIC-SROP activities are organized by a program coordinator and staff to promote a faculty-mentored research project and peer engagement as well as academic excellence, graduate studies, and research career socialization.

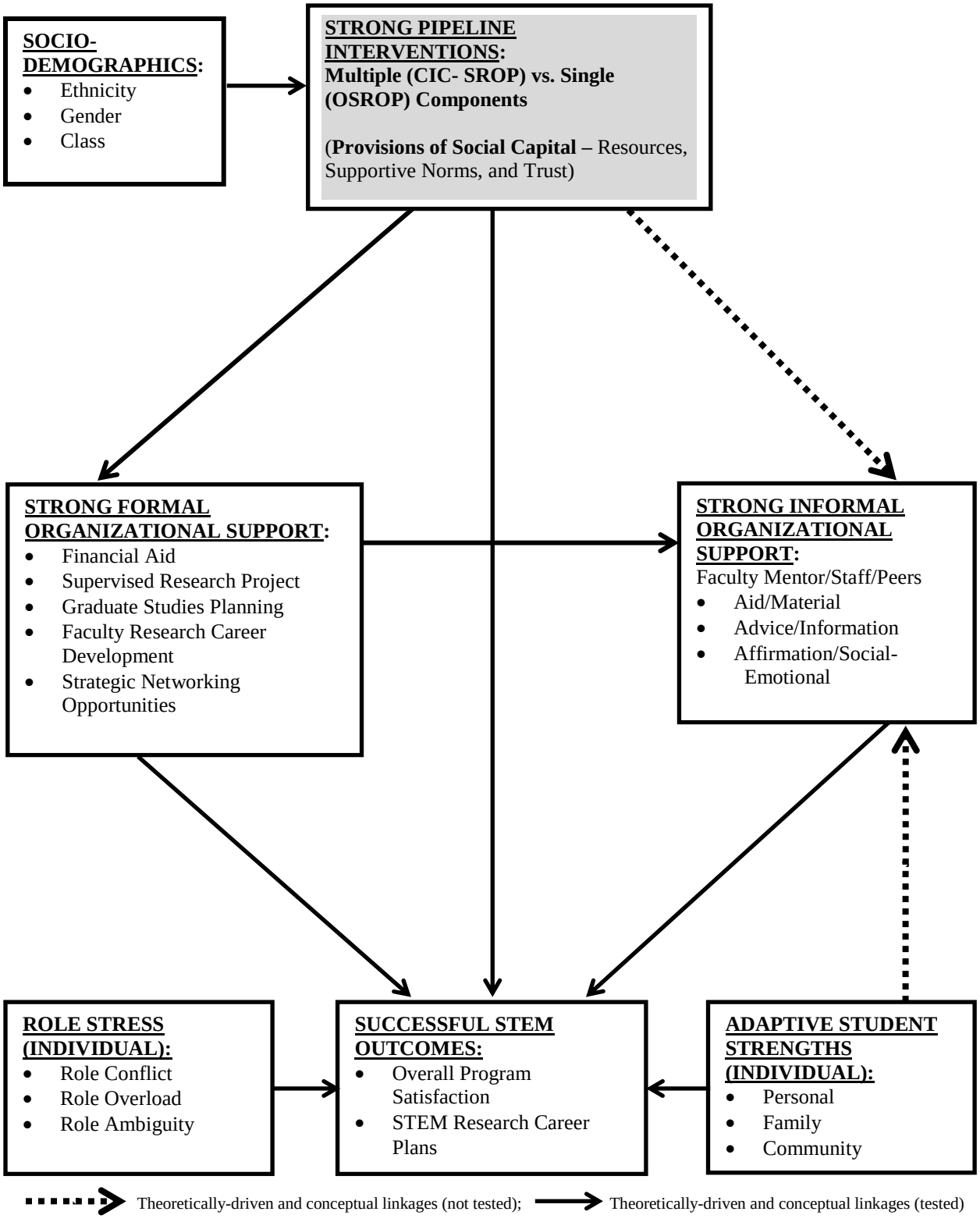
The CIC-SROP combines a faculty-mentored research experience with a comprehensive set of resources during an intensive eight-week summer program to promote Ph.D. studies among underrepresented students as a bridge to faculty research careers. Also included in this study are CIC-SROP applicants who participated in a variety of other SROP (OSROP) research

experiences for undergraduates including some funded by NIH, NSF, and other sources. These OSROP experiences vary widely but unlike CIC-SROP are *not* formally designed to be a strong intervention that includes multiple components and social capital. Including both CIC-SROP and OSROP participants in the present study allows the systematic exploration of three strong organizational mechanisms – program social capital, formal organizational support, and informal organizational support – to better explain intervention outcomes. Figure 1.2 describes a comprehensive strengths-based model highlighting the manner in which these mechanisms are interrelated, and how they may help to explain successful STEM outcomes (Bowman, 2011a, 2013; Maton et al., 2000; Trent & St. John, 2008).

A Comprehensive Strengths-Based Conceptual Framework

As highlighted in Figure 1.2, the present study explores how organizational mechanisms within exemplary pipeline interventions such as CIC-SROP may promote successful STEM outcomes. This conceptual model integrates theoretical insights from both sociological and social psychological research for a more penetrating analysis of the three pivotal organizational mechanisms. The comprehensive framework builds on organizational theory and research related to social capital (Coleman, 1988; St. John, Hu, & Fisher, 2011), organizational support (Eisenberger & Stinglhamber, 2011; Katz & Kahn, 1978), and role stress and adaptive coping (Bowman, 2013; Kahn et al., 1964). Strong formal and informal organizational supports are conceptualized as pivotal intervening mechanisms between strong interventions and successful STEM outcomes. This research suggests that elements in strong interventions (multiple components and social capital) enhance both formal and informal organizational support which, in turn, promotes successful STEM outcomes. Going beyond evaluation studies, this study can

Figure 1.2: Intervention Social Capital, Organizational Support, and STEM Outcomes: A Strengths-Based Role Stress and Adaptation Approach



help to explain why participation in strong interventions often shows direct effects on successful STEM outcomes.

Major Propositions

Rather than a general path analysis, this exploratory study builds on the conceptual model in order to: (1) further refine reliable and valid measures of both formal and informal organizational support within undergraduate pipeline interventions, and (2) explore the predictive relationships among formal and informal organizational support, overall program satisfaction, and STEM outcomes among UR students. As illustrated in Figure 1.2, the present study builds on the integrative conceptual framework to focus on ***five major propositions***: (1) strong pipeline interventions which include the provision of social capital (multiple resources, supportive norms, and interpersonal trust) promote positive STEM outcomes; (2) strong formal organizational support, characterized by participants' satisfaction with specific program components, will enhance the positive intervention effects on STEM outcomes; (3) strong informal organizational support from program mentors, staff, and co-participants will enhance positive intervention effects on STEM outcomes; (4) the positive effects of strong formal and informal organizational support on intervention efficacy will be greatest for UR students faced with high levels of student role stress; and (5) the adaptive strengths of UR students can buffer the adverse effects of role stress on STEM outcomes.

In general, strong pipeline interventions provide unique opportunities for UR students who often face systematic barriers and must overcome prior achievement gaps. The present study not only will only focus on outcomes but also will probe for a deeper understanding of the underlying mechanisms through which a strong SROP organizational support system promotes successful STEM outcomes. To go beyond past evaluation and descriptive studies, there is a

need to better understand how strong organizational support mechanisms in exemplary pipeline interventions foster success for UR students, who often have lacked the opportunity to experience preparation equal to privileged peers. As illustrated in Figure 1.2, social capital elements within CIC-SROP are conceptualized as major antecedents of strong organizational program support which, in turn, may directly influence individual STEM outcomes. Hence, it appears that an exemplary intervention which cultivates social capital creates a strong organizational context for both formal and informal support of individual students when needed. In social systems terms, strong CIC-SROP social capital elements at the intervention program or meso-system level may operate at the individual level through strong formal and informal support to promote successful outcomes.

Consistent with the five propositions, a growing body of research on UR students supports the importance of: (1) better understanding the operation of multiple program components in the efficacy of comprehensive interventions (Maton, Hrabowski, & Schmitt, 2000), (2) conceptualizing the multiple components of strong intervention programs in terms of strong social capital elements (Lee, 2003; St. John, Hu, & Fisher, 2011; Trent & St. John, 2008), and (3) clarifying how formal organizational support within the pipeline intervention contexts, combined with informal support from multiple sources, can further boost successful outcomes (Hrabowski, Maton, Green, & Greif, 2002; Hrabowski, Maton, & Greif, 1998). The influence of social capital on the intervention outcomes of individual participants may be mediated by strong organizational and informal support. Research based on social psychological theory has long shown that perceived organizational support — both formal and informal — promotes successful organizational and individual outcomes (Kahn, Wolfe, Quinn, Snock, & Rosenthal, 1964; Katz & Kahn, 1978; Eisenberger & Stinglhamber, 2011).

Comprehensive pipeline interventions such as CIC-SROP provide social capital elements including supportive networks, a wide range of resources, and multiple program components as illustrated in Figure 1.2. Therefore, this study views the exemplary CIC-SROP pipeline interventions in terms of the strong social capital they provide, such as supportive resources, supportive norms, and trust (Allen & Zepeda, 2007; Davis, 2007, 2008; Foertsch, Alexander, & Penberthy, 2000; Girves, Zepeda, & Gwathmey, 2005; Zepeda, 2010). Social capital features such as supportive networks (Lin, 1999; Portes, 1998), information sharing (Coleman, 1994), and information channels (Farmer-Hinton & Adams, 2006) facilitate the social exchange of resources, norms, and trust, and may be vital to the success of UR students. Specifically, the social capital concept implies the importance of systematically employing institutional agents both formally and informally within the organizational context of exemplary pipeline interventions. By extension, these interventions must link several social capital elements to individual participants when needed through both formal and informal organizational support, further reinforcing trustworthy networks and successful outcomes.

Major Study Contributions and Research Questions

The present study employs a panel survey design and quantitative methodology to systematically investigate the five strengths-based propositions described above. Its three major contributions are as follows: First, as a policy-relevant study, it explores the benefits of strong SROP intervention that responds to the national call for effective pipeline efforts to boost STEM talent development among UR students and keep America competitive. Second, as a theory-driven study, it goes beyond past descriptive and evaluation studies to better clarify the organizational mechanisms that help to explain successful STEM outcomes. Finally, building on an emerging body of strengths-based research, this empirical study provides a conceptual model

that can guide the development of reliable and valid measures of both formal and informal organizational support that will be useful for future research on UR students in strong pipeline interventions.

Over the past decade, the NIH, the NSF, and other funding agencies increasingly have emphasized the importance of theory-driven studies to better understand the pivotal mechanisms that make STEM pipeline interventions effective and innovative. For example, since 2005, the NIH-NIGMS and its Division of Training, Workforce Development, and Diversity (formerly Minority Opportunities in Research) have funded several innovative studies to provide insight into factors that explain successful intervention outcomes. Over 27 studies have been funded under their "Research to Understand and Inform Interventions that Promote Research Careers" grant in order to "support research that will test assumptions regarding existing or potential interventions that are intended to increase the preparedness for careers in biomedical research, with a particular interest in the interventions specifically designed to increase the number of UR students entering careers in biomedical and behavioral research" (NIH-NIGMS Website).

Major Research Aims and Specific Research Questions

The major aims and specific research questions guiding the present study represent the critical issues that are focused on in one of these 27 NIH-NIGMS funded projects (see Figure 1.2). Within a comprehensive strengths-based framework, a strong pipeline intervention should be systematically organized to offset the adverse effects of status-related barriers facing UR students by: (1) having multiple rather than single resource components, (2) providing both formal and informal support, and (3) mobilizing adaptive strengths that UR students often bring to intervention settings. Based on this definition, the current study is organized around two major aims – the first focused on measurement issues and the second focused on predictive

relationships. Rather than exact hypotheses, this exploratory study investigates each major aim with a specific focus on a set of related research questions.

A. Research Aim 1: Building on a comprehensive strengths-based framework, develop *reliable and valid measures* of strong formal and informal organizational support that are useful for research on UR undergraduate students in summer research pipeline interventions:

(1a) Are there significant *gender and ethnic differences* among pipeline intervention participants on specific items used to measure the multiple components of *formal* organizational support?

(1b) Do UR students in the more strongly designed CIC-SROP programs actually perceive higher levels of *formal* organizational support than UR students in other pipeline interventions (OSROPs) with fewer *formal* program components?

(1c) In addition to *formal* organizational support, do UR students in SROP interventions also benefit from *strong informal organizational support* from three major program sources - *faculty mentors, staff and peers*?

(1d) Can strong *formal and informal* organizational support within pipeline interventions be measured with *reliable and valid scales* that include empirically distinguishable *subscales* representing multiple components? Can *formal* organizational support scales and subscales help to better clarify *meaningful differences* between strong CIC-SROP and other SROP interventions? Is there a significant relationship between strong *formal and informal* organizational support *scales*?

B. Research Aim 2: Explore how strong formal and informal organizational support measures may help to explain overall program satisfaction and successful STEM research career plans among UR students in summer research pipeline interventions.

(2a) In addition to objective pipeline intervention participation, do *formal and informal* organizational support factors further enhance program satisfaction and successful STEM outcomes?

(2b) Are the effects of *formal and informal* organizational support on successful STEM outcomes stronger among pipeline intervention participants facing higher role stress?

(2c) In addition to strong organizational support, do "adaptive strengths" among pipeline intervention participants help to buffer any deleterious effects of role stress on their successful STEM outcomes?

The second chapter of this dissertation highlights the relevant literature linked to this investigation. Chapter III provides a description of the sample, measures, and analytic strategy employed. The results are presented in Chapter IV, followed by a summary and discussion in the final chapter, with an eye to the implications of this research for practice and policy.

CHAPTER II

LITERATURE REVIEW

In order to improve global competitiveness, expand the nation's research agenda, and increase diversity among researchers who choose science as a career, many higher education institutions and U.S. science agencies have increased the number of minority research training programs and undergraduate research experiences, in fields as diverse as science, technology, engineering, mathematics, health, and agriculture (Nivet, 2010). The United States STEM workforce currently has disproportionately low numbers of members of rapidly increasing population groups such as African Americans, Hispanics, and Native Americans. This imbalance persists despite diversity efforts over the past 30 years. Underrepresented racial and ethnic groups "accounted for approximately 29.4% of the U.S. population in 2010 but accounted for only about 13.3% of employed scientists and engineers" (Allen-Ramdial & Campbell, 2014, p. 1). As indicated in previous literature (CAWMSET, 2000; Chen, 2009; Dowd, Malcom, & Bensimon, 2009; Frehill & Di Fabio, 2008; Frehill, Di Fabio, & Hill, 2008; GAO, 2006; Malcom, Van Horne, Gaddy, & George, 1998), this disparity leaves untapped a pool of domestic talent that could be trained to address the science research and development agenda of the nation, as well as possessing a cultural awareness of the challenging issues faced by historically marginalized populations.

The purpose of this dissertation is to further examine the nation's ability to create a critical mass of domestic STEM researchers by investigating the impact of formal and informal organizational support on intervention program participants, focusing on the differential benefits experienced by these students. Maton & Hrabowski (2004) provide an extensive review of the growing STEM pipeline literature in the United States, which further clarifies the multiple components of the most successful interventions. This review suggests that from an organizational perspective the most prominent program components of successful interventions include strong formal support, such as faculty-supervised research experience, financial assistance, academic skill development activities, graduate education planning activities, and career planning and enrichment activities, and strong informal support, such as from faculty mentors, staff, and peers.

The literature related to the present strengths-based study will be reviewed in this chapter, with a focus on exemplary pipeline interventions and the related concepts of social capital, strong formal and informal organizational support, role stress, and adaptive multilevel strengths. This literature provides a general background for the conceptual framework that guides the present empirical study, as outlined in Chapter I. To begin, this more detailed review of related literature is organized around a focus on the relevance of strong pipeline interventions, strong formal organizational support, and strong informal organizational support for successful STEM outcomes. Guided by the stress and coping literature, this chapter also will explore how organizational support and adaptive individual strengths might buffer the adverse effects of role stress on successful STEM outcomes among UR students in intervention settings.

Strong Pipeline Interventions: Multiple vs. Single Components

Matyas and Dix (1992) define an intervention program that "identified a problem to solve, select and implement a strategy (either to change the situation or to compensate somehow for a situation that you cannot change) and then continually monitor to see if your strategy is successful" (p. 16). Lentz and Allen (1996) characterize strong interventions as having "to do with increasing probabilities of positive change, the degree of preparedness, and system change efforts" (p. 120):

> … whenever someone makes a plan to intervene with a problem situation, they desire positive change. Therefore, it is reasonable to define an intervention as "doing something different to solve some perceived problem". Further, it makes sense that there is a continuum of effectiveness and a related continuum of the extra effort required to be more effective than the current situation. Yeaton and Sechrest (1981, p. 156) have defined strong treatments as those containing "large amounts in pure form of those ingredients leading to change". (p. 120)

In the present study, strong interventions are defined as those designed with multiple programmatic components embedded within the organization that promote participants' success (CGS, 1992; Maton, Hrabowski, & Schmitt, 2000). Conversely, a single component intervention is limited in organizational structure (Good, Halpin, & Halpin, 2001; Good, Halpin, & Halpin, 2002; McShea & Yarnevich, 1999). Good and colleagues (2002) explained the academic support provided for UR students in a minority engineering support program and its positive impact on academic achievement in the first year of college. However, their results indicated that the benefits to academic achievement diminished over time within a monolithic program structure. A multiple-component or comprehensive pipeline program has multifaceted support structures that

include academic learning but also other offerings. While some comprehensive programs are developmental, others are non-remedial by the nature (Trent & Gong, 2006). Both the University of Michigan Women in Science and Engineering Residence Programs (WISE-RP) and the University of Maryland, Baltimore County (UMBC) Meyerhoff Scholars Program are recognized as exemplary because of their successful design, practice, and efficacy (BEST, 2004).

Some pipeline intervention research studies emphasize high-impact educational practices that focus on building faculty-student undergraduate research opportunities (Kuh, 2008). These opportunities are typically designed to allow the students to hone skills, gain knowledge, and understand the value of scholarship production as a way to increase the nation's critical mass of well-trained scientists. In addition, these programs are designed as training mechanisms to propel the U.S. STEM research and development enterprise, as a means to solving critical problems that infringe upon the well-being of our citizens. Originally offered in order to advance undergraduate students in science disciplines (Boyd & Wesemann, 2009; Boyer Commission on Educating Undergraduates, 1998, 2002), undergraduate research opportunities have expanded to target college students from many backgrounds and are considered especially beneficial for cultivating their interest in STEM research careers. Undergraduate research expands experiential learning beyond the classroom, and increases the role of universities as "interventionists" to help diversify STEM research career professions (Winkleby et al., 2009).

Strong Pipeline Interventions: Provisions of Social Capital

The first section of this chapter clarified the social organization of strong pipeline interventions through a study of participants' experiences with both the formal organizational resources provided by the program and the informal organizational support from faculty mentors, program staff, and co-participants. In the social capital literature, this research question focuses

on the importance of understanding exemplary pipeline interventions as organizational networks that systematically provide a bundle of assets, resources, supportive norms, and informal relationships that can function to encourage and motivate participants to pursue STEM careers (Coleman, 1988; Lee, 2003; St. John, Hu, & Fisher, 2011; Trent & St. John, 2008). While interventions can serve as organizational vehicles for STEM pipeline development, participants have an opportunity to access comprehensive resources, benefit from supportive program norms, and establish strong interpersonal bonds with program agents that build trusting relationships. According to Coleman (1988) and other social capital theorists, interventions that provide a strong combination of supportive organizational networks, resources, norms, and relationships can better function to yield successful STEM outcomes.

Building on social capital theory, a growing body of literature on exemplary pipeline interventions targeting talented UR and underserved populations indicates that comprehensive program components, within the structure of an intervention, are designed to offer elements of social capital (Bourdieu, 1986; Coleman, 1988; Dika & Singh, 2002; Loury, 1977, 1987; Portes, 2000; Putnam, 1993). Despite diverse perspectives, social capital theorists generally agree on the functional benefits of organizational networks that provide members with supportive resources, norms, and relationships. These common elements in social capital theories support the importance of better understanding exemplary pipeline interventions as organizational networks (Lee, 2003; St. John, Hu, & Fisher, 2011; Trent & St. John, 2008). By clearly identifying the social capital elements against which interventions can be compared, and by assessing the strength of the social capital offered in them, we can better understand how strong interventions better promote preparation, matriculation, and other successful student outcomes.

In the context of pipeline programs, a theoretical framework is necessary to explain social capital as a key organizational concept. Scholars such as Loury (1977, 1987) and Ben-Porath (1980) have wrestled with the concept as either a "phenomenon of resources" or "capital through social relations" (Lin, 2000, p. 21); however, the most popular viewpoint is in alignment with perspectives from prominent sociologists. Most research studies examine Coleman's (1988, 1990) social capital theory as it applies to the social sciences, in particular the U.S. educational system. Like concepts such as student access, student persistence, and STEM, social capital has been defined and refined by many prominent scholars. As a sociological concept, social capital initially was theorized by both French sociologist Pierre Bourdieu and American sociologist James Coleman (Dika & Singh, 2002; Portes, 2000). Bourdieu's (1986) work focused on the commonalities and the collective power of different types of capital (e.g., economic, cultural, and social capital), while Coleman's (1988) research focused on social capital as a determinant for building human capital. Both scholars acknowledged that social networks, relationships, and weak and strong ties (Granovetter, 1973, 1985) are critical for maximizing the benefits of an individual's social capital. However, Bourdieu's conceptualization of social capital is nested within theories of social reproduction and symbolic power by way of access to institutional resources, whereas Coleman's has a structural-functionalist foundation (Dika & Singh, 2002).

Most social capital theorists have wrestled with the concept primarily as a phenomenon of either resources or capital through social relations (Lin, 2000, p. 21). As a sociologist, Coleman (1988) employed the social capital concept to better understand the social organization of effective schools and classrooms, with a particular emphasis on the role of social capital for building human capital in the American educational system. More specifically, Coleman's structural-functionalist definition views social capital as: "… a useful resource available to an

actor through his or her social relationships. It comprises a variety of entities [that] all consist of some aspect of social structures, and they facilitate certain actions of actors – whether persons or corporate actors – within the structure. (Coleman, 1988, p. 98)

Coleman focused on students, classrooms, and schools within the broader context of a multilevel social organization and considered the critical role of resources within families and communities. He further refined his multilevel social capital definition as:

> … the set of resources that inhere in family relations and in community social organization and that are useful for the cognitive or social development of a child or young person. These resources differ for different persons and can constitute an important advantage for children and adolescents in the development of their human capital. (1994, p. 300)

Dika and Singh (2002) noted that Coleman's social capital approach is grounded in rational choice theory with an emphasis on norms and social control, and noted that Coleman "proposes that social capital is intangible and has three forms: (1) level of trust, as evidenced by obligations and expectations, (2) information channels, and (3) norms and sanctions that promote the common good over self-interest" (p. 33). Similarly, Baron, Field, and Schuller (2000) observed that Coleman's stance revolved around people "acting rationally in pursuit of their own interests" (p. 13).

Herreros (2004) noted that both Coleman's and Bourdieu's works have contributed to the popular structural definition of social capital "as a range of resources available to individuals thanks to their participation in social networks" (p. 6). Linking social capital to social support, Bourdieu (1977) initially defined social capital as: "… a capital of social relationships which will provide, if necessary, useful "supports": a capital of honourability and respectability which is

often indispensable if one desires to attract clients in socially important positions" (p. 503). Two decades later, Bourdieu and Wacquant (1992) refined this definition to the following: "Social capital is the sum of resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition" (p. 119).

In contrast to Coleman's structural-functionalist approach, several theorists conceptualize social capital as nested within conflict theories of social reproduction and symbolic power by way of differential access to institutional resources (Bourdieu, 1996; Dika & Singh, 2002; Portes, 1998; Putnam, 1993). Bourdieu's approach focuses on concepts such as cultural capital, habitus, and field to examine institutionalized barriers and the maintenance of social hierarchies (Dika & Singh, 2002, p. 33). As such, it comes from a neo-Marxist standpoint that promotes "accumulated labor" to reproduce practices of inequality such as resources and power (Field, 2003; Schuller, Baron, & Field, 2000). From this more critical perspective, social capital also can be an exclusionary vehicle whereby many are denied access to personal networks that therefore benefit only the elite, especially in terms of preserving their superior societal status. According to Dika and Singh (2002), "Bourdieu's social capital is decomposable into two elements: first, the social relationship that allows the individual to claim resources possessed by the collectivity, and, second, the quantity and quality of those resources" (p. 33). Bourdieu (1996), as cited in Dika and Singh (2002), also proposes:

> that the volume of social capital possessed by a person [is] based on size of the network of connections that he or she can mobilize and on the volume of capital – economic, cultural, and symbolic – possessed by each person to whom he or she is connected. (p. 3)

Bourdieu's consideration of social reproduction and inequalities is a critical reminder that not all UR students have access to successful pipeline program resources and that the many non-participants may face systematic barriers to social capital that continue to reproduce inequalities and social hierarchies. Despite their efficacy, exemplary pipeline interventions can become conduits for tokenism or selective sponsorship that exacerbate existing levels of inequality in either a highly interconnected or a segmented society (Halpern, 2005). Therefore, if these highly selective interventions are not made more broadly available, they could merely provide a small elite class of UR students with expanded access to social capital and the opportunity to partake in the social exchange. Moreover, the social capital literature also provides evidence that not all students in the same intervention will be able to take advantage of the social networks in the same way. Therefore, social capital theory thus helps to explain why highly selective sub-groups of UR students have differential outcomes. In addition to elite sponsorship, more resilient UR students may also have higher levels of adaptive strengths that promote successful outcomes.

In rigorous strengths-based evaluation studies, attention should be given to both (1) the systematic manipulation of strong social capital elements within exemplary pipeline interventions and (2) the differential operation of naturally-occurring social capital elements across comparison groups. It is therefore critical to better understand the operation of the naturally occurring elements, because there are multiple ways to accumulate social capital; it is the result of multiple organizational components, activities, and interactions (Coleman, 1988; Putnam, 1993; Field, 2003). For example, critics have argued that if social capital is the by-product of a wide range of activities, from participation in associations to membership in a more or less dense network of friends, we need to better clarify how formal sources of social capital within interventions combine with more informal or naturally-occurring sources (Field, 2003, p.

78). Given the inequalities faced by UR students, we also need to explain how multilevel social networks can operate as systematic sources of both social capital and social system barriers and threats. Researchers have identified at least three negative attributes of social capital: (1) lack of information about how to cultivate it, (2) inequalities in education, and (3) social capital creation as a by-product not a stand-alone construct.

For the STEM research agenda, historically black colleges and universities (HBCU) and minority serving institutions (MSI) are the leading producers of minority scientists (Allen, 1992; Committee on Equal Opportunities in Science and Engineering, 2004; Elliott, Strenta, Adair, Matier, & Scott, 1996; Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011; May & Chubin, 2003; Perna, Lundy-Wagner, Drezner, Gasman, Yoon, Bose, & Gray, 2009; Trent & Gong, 2006). Brown and Davis's (2001) notion of HBCUs as "purveyors of social capital" is based on Bourdieu's (1977) theory of social reproduction theory in which "social properties are generated, given value, and reified among individuals in social institutions" (p. 40-41).

> Through these means an individual may gain entry and secure social rewards, such as status, privilege, and position in particular social circles, professions, or organizations (Bourdieu, 1973). Social capital marks and reinforces differing kinds of relative advantage and disadvantage within African American communities and in the general society. Therefore, social capital is particularly useful in understanding the historic and contemporary role of HBCUs. Because of their unique constellation of Black intellectuals and professionals among institutional staff and alumni, HBCUs serve as conduits for the production and transmission of social capital to African American students. Furthermore, Black colleges offer institutional agents and agencies such as committed faculty, compensatory curricula, alumni leaders in the professions and society (Stanton-Salazar,

> 1997). These institutional agents constitute an array of channels that identify, negotiate, and transmit resources, particularly formal and informal relations, that purchase opportunities for the accomplishment of HBCUs' collective agenda – the educational development and attainment of African Americans. (Brown & Davis, 2001, p. 41)

Therefore, similar to HBCUs, strong pipeline interventions also are organized with multiple components to provide elements of social capital as well as formal and informal support.

Formal and Informal Support: Preventers of Stress Appraisal as Buffers

In efforts to better understand human organizations such as a strong pipeline intervention, social scientists need to specify the multilevel mechanisms underlying the positive impact of these interventions on successful student outcomes. For example, it is important to make a multilevel distinction between the purposes or goals of organizations (programs) in the form of social capital and the related purposes or goals of individual members in the form of perceived social support (Katz & Kahn, 1978, p.19). "Using Lazarus's appraisal model of stress (e.g., Folkman & Lazarus, 1991), Cohen and Wills (1985) suggested that [perceived] social support [at the individual level] might reduce stress initially by lessening the appraisal of a stressor as a threat to control. [Moreover, once] a stressor was interpreted as a threat, social support might lessen its influence by reappraisal of the threat, inhibition of maladaptive responsive to it, or facilitation of adaptive counter responses to the threat" (as cited in Eisenberger & Stinglhamber, 2011, p. 148-149). The social support provided by others is a general protective factor that may prevent stress appraisal in conditions of threats of role stress (Richman, vanDellen, & Wood, 2011). When such threats occur, both formal and informal sources of support may be available.

Strong Formal Support: Multiple Program Components

As illustrated in the conceptual model (Figure 2.1), the relationship between social capital and individual intervention outcomes may be strengthened by strong formal and informal support. Social psychological theory and research on organizations have long shown that perceived organizational support – both formal and informal – promotes successful organizational and individual outcomes (e.g., Kahn, Wolfe, Quinn, Snock, & Rosenthal, 1964; Katz & Kahn, 1978; Eisenberger & Stinglhamber, 2011). This support comes in many forms, including formal involvement in undergraduate research initiatives, many of which directly provide a variety of supportive organizational activities.

Comprehensive pipeline programs such as the Louis Stokes Alliance for Minority Participation, the McNair Scholars Program, and the Meyerhoff Scholars Program provide a supportive network and a wide range of resources to program participants. Such programs provide undergraduate students with multiple types of research experiences in order to build student capability across the entire range of sciences – social, life, and physical. These experiences are: ***undergraduate research experience*** (e.g., Davis & Finelli, 2007; Elgren & Hensel, 2006; Fechheimer, Webber, & Kleiber, 2011; Hu, Kuh, & Gayles, 2007; Merkel, 2001, 2003), ***summer undergraduate research experience*** (e.g., CGS, 1992; Davis, 2007, 2008, 2010; Foertsch, Alexander, & Penberthy, 1997), ***STEM undergraduate research experience*** (e.g., Davis & Finelli, 2007; Hathaway, Sharp, & Davis, 2001; Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009; Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011; Merkel, 2001; Russell, Hancock, & McCullough, 2007; Thiry & Laursen, 2011; Thiry, Laursen, & Hunter, 2011; Tsui, 2007; White, Blaisdell, & Anderson-Rowland, 1998), ***summer STEM undergraduate research experience*** (e.g., American Speech-Language-Hearing Association,

2011; Armstrong & Thompson, 2003; Falconer & Holcomb, 2008; Hunter, Laursen, & Seymour, 2007; Junge et al., 2010; Kardash, 2000; Merkel, 2001; Pender, Marcotte, Sto. Domingo, & Maton, 2010; Seymour, Hunter, Laursen, & Deantoni, 2003; Strayhorn, 2010; Winkleby et al., 2009), ***NIH/NSF undergraduate research training programs*** (e.g., DePass & Chubin, 2008; Kardash, 2000; Merkel, 2001; National Institute of Allergy and Infectious Diseases, 2006), and ***structured undergraduate research programs with a summer research experience component*** (e.g., Adedokum et al., 2013; Barisa & Holland, 1993; Barlow & Villarejo, 2004; Carter, Mandell, & Maton, 2009; Chubin, DePass, & Blockus, 2009; Clewell, deCohen, Tsui, & Deterding, 2006; Committee on Equal Opportunities in Science and Engineering, 2004; DePass & Chubin, 2008; Elliott et al., 1996; Lopatto, 2004; Lopatto, 2007; Maton & Hrabowski, 2004; Maton, Hrabowski, & Ozdemir, 2007; Maton, Hrabowski, & Schmitt, 2000; May & Chubin, 2003; Merkel, 2001; Olson & Fagen, 2007; Russomanno et al., 2010; Sharp, 2000; Stolle-McAllister, Sto. Domingo, & Carrillo, 2011; Tsui, 2007).

Throughout this literature on comprehensive pipeline programs, the concept of strong formal support at the organizational level relies on the following parameters (Zepeda, 2010): (1) a supervised research project, (2) financial aid, (3) academic skill development activities, (4) graduate studies planning, and (5) career planning and enrichment activities. These formal support parameters, in turn, illuminate a key underlying organizational mechanism guiding successful STEM outcomes.

Supervised Research Project

The supervised research project appears critical to successful STEM outcomes of pipeline interventions, especially in the form of undergraduate research programs. The establishment of these formal opportunities involving undergraduates working closely with faculty, research

associates, or graduate students has proven to be effective in fostering successful research and academic experiences for high-achieving minority students (Reichert, 2006). While the literature is not extensive, there are important aspects to consider in cultivating formal supervised research experiences, in order to successfully encourage future scientists to pursue innovative and effective research methods as a profession. "Most of these programs operate under the assumption that actively engaging students in research and related professional activities will stimulate their interest in the understanding of science and encourage them to pursue research careers" (Fagen & Labov, 2007, p. 187). This type of deliberate action will increase the production of scientific expertise that could enable the U.S. to be scientifically and technologically innovative and competitive with other countries.

Within academia, there has been a growing effort to implement supervised research programs targeted at UR populations (Carreathers, Beekmann, Coatie, & Nelson, 1996; Landis, 1985; Maton, Hrabowski, & Schmitt, 2000; Shay, 2000; Thomas, 1985). The hope is that these research programs will increase the number of STEM graduates and research career professionals among UR populations (National Science Foundation, 2000, 2007; Strenta, Elliott, Russell, Matier, & Scott, 1994; Thomas, 1992). In an effort to do so, scholars have designed interventions that attempt to link practical and research-based approaches. The formal supervised research project thus plays a key role in both participants' program satisfaction and their STEM research career plans.

Financial Aid

Financial aid represents a second important focus for programmatic action. A large number of quantitative studies on formal support in pipeline programs examine the effects of financial aid on educational outcomes (Ishitani & DesJardins, 2002; Perna, 2005; Ramos, 2011;

St. John, 1991). The more comprehensive pipeline interventions have combined financial aid, academic preparation, educational planning, and social/personal development as a means to promote educational success (Trent & St. John, 2008). Interventions that also provide orientation seminars that are related to financial assistance are shown to influence preparation, college-going behaviors, and ultimately success behaviors (Broatch, 1989; St. John, 2003). Paid undergraduate research experiences as a source of financial aid are linked to high levels of success, which complement and enrich the students' experiential learning, and help defray the cost of college. This latter point is especially salient for UR students, who are more likely to face unmet financial need (Gandara & Maxwell-Jolly, 1999; Johnson, 2007; Long & Riley, 2007; Tsui, 2007). Participation in field-specific research interventions has overwhelmingly had a positive impact on undergraduate women and UR students' success in math and proficiency in computer applications (Clewell & Campbell, 2002; May & Chubin, 2003; Wyer, 2003). Undergraduate research interventions also serve as a conduit between academic and industry stakeholders, by combining resources to better recruit and train a diverse, technologically advanced workforce. These partnerships have the added benefit of providing paid summer internships to participants who are highly motivated and academically successful, further increasing their likelihood of a successful STEM career.

Research has shown that increased financial aid, financial support, and financial attitudes are important predictors of student success (Allen, Bonous-Hammarth, & Suh, 2004; Cabrera, Nora, & Castaneda, 1992; St. John, Kirshstein, & Noell, 1991; Thomas, 1985), especially for minority students in engineering (May & Chubin, 2003). Student socioeconomic status (SES) has been demonstrated to affect the choice of a major; low-SES students are more likely to choose

vocational majors with modest earnings potential than lucrative majors (Goyette & Mullen, 2006).

Graduate Studies Planning

Graduate studies planning represents the third important area for programmatic intervention. Research suggests that academic planning within undergraduate research pipeline interventions is vital for successful STEM outcomes, particularly for underrepresented populations (George, Neale, Van Horne, & Malcom, 2001; Matyas & Malcom, 1991). Their experiences with research have been demonstrated to be influential in their graduate studies planning (Foertsch et al., 1997; Strayhorn, 2010). Pender, Marcotte, Sto. Domingo, and Maton (2010) cited participation in undergraduate research experiences as one way to be socialized into graduate-level education by giving "students an opportunity to interact with graduate students who are a great source of information about the graduate school experience" (p. 8). Much has been written about the role of graduate studies planning in the undergraduate research training process of STEM students (Bauer & Bennett, 2003; Hathaway, Nagda, & Gregerman, 2002; Russell, Hancock, & McCullogh, 2007; Hunter, Laursen, & Seymour, 2007; Lopatto, 2003, 2007; Thiry, Laursen, & Hunter, 2010), yet few of these studies are based on empirical data regarding the relationship between undergraduate research experiences and STEM research career plans.

Faculty Research Career Development

Formal faculty-mentored experience (Blake-Beard, Bayne, Crosby, & Muller, 2011) in undergraduate research represents the fourth integral programmatic factor that is linked to high levels of success in STEM (Thiry & Laursen, 2011). Participation in such a pipeline intervention contributed to students' satisfaction with their authentic research experience and "clarified,

confirmed, or refined their career and educational goals" (Thiry, Laursen, & Hunter, 2011, p. 377). Davis (2007, 2008, 2010) interviewed Summer Research Opportunity Program students at fifteen CIC sites who conducted research with their assigned faculty mentor. Similarly, Foertsch, Alexander, and Penberthy's (1997) investigation of participants in the SROP found that more than 50% of them enrolled in graduate school.

Strategic Networking Opportunities

Student professional organizations foster social relationships that enable members to perform reciprocity functions, such as networking, that enhance social support. There is a body of research that links student membership in such organizations to student success. According to Hartman and Hartman (2005), the mechanisms by which organizational involvement enhances student retention and student persistence include social integration and self-help, especially when the organizations are configured to provide support activities to their members (p. 199). The authors further postulate that:

> … participation in student chapters of professional organizations is likely to provide benefits to the participants, particularly in the area of social capital. Although some of this social capital would accrue from participation in any student organization, other benefits, tied more specifically to professional socialization into the profession, would result from participation in student chapters of the professional organization. (p. 119)

Professional organization membership improves students' success by enhancing their commitment to pursuing the STEM profession (Kuh, Schuh, Whitt, & Associates, 1991; Tinto, 1993). Several researchers have recognized commitment as a primary general predictor for success (e.g., Leslie, McClure, & Oaxaca, 1998). On the other hand, the extant literature suggests that membership within a preference-specific organization (i.e., one based on race, ethnicity, or

gender) presents a barrier to success in engineering (Tonso, 1998). Specifically, some students and scholars suggest that these organizations marginalize minority groups rather than creating parity within the engineering community (Fournier & Kelemen, 2001). Talbert, Larke, and Jones (1999) noted that often there is a lack of resources and mentors that could contribute to the success of undergraduate minority students. Organizations that allow students to cluster and share college experiences are considered incubators for success. They also provide opportunities for students to be socially networked into the academic and campus environment.

Hartman and Hartman (2005) used factor analysis to analyze data on undergraduate engineering students at Rowan University during the 2000-2001 academic year. They examined the participants' choices to associate with student chapters of discipline-specific, gender-specific professional organizations – such as the student chapter of the Society of Women Engineers (SWE) – or to join no association at all. These organizations contribute to improved interpersonal relations among peers and faculty. SWE participants had closer contact with faculty than non-participants, and student members made greater use of study and counseling opportunities. In this case, student members seemed to be supported and enhanced rather than diminished by their involvement in SWE. The formation of supportive ties among SWE members did not appear to marginalize or isolate women.

Student professional organizations or networks also can help students overcome academic challenges (Hartman & Hartman, 2005), promote student socialization within STEM, and assist unsure students who consider leaving an academic discipline (Talbert, Larke, & Jones, 1999). These qualitative studies suggest that formal program activities combine with informal support from faculty mentors to create positive program experiences and academic success. For the most part, UR students have weaker network ties, and professional organizations such as

SWE, the National Society of Black Engineers (NSBE), and the Society of Hispanic and Professional Engineers (SHPE) address this area. However, quantitative studies have yet to clarify the relationship between formal program components and informal support patterns.

Strong Informal Organizational Support

In addition to strong formal organizational support, this dissertation's conceptual model highlights the importance of strong informal program support as a critical mechanism for promoting successful intervention outcomes. As suggested here, the importance of better understanding the effects of both formal and informal organizational support is emphasized by the abundant research on adaptive coping (Burke, 1996; House, 1974; Kaplan, 1996; Pearlin, 1989). Informal social support from program mentors, staff, peers, and family members may operate to promote successful educational and career outcomes among UR students (e.g., Baron & Kenny, 1986; Ebreo, 1998; Reyes, 2002). Guided by existing theory and research, this study utilizes a range of strong formal and informal support measures that might enhance intervention efficacy. For example, strong informal support from sources both within and outside of an intervention setting may provide UR students with the material assistance, guidance, and socio-emotional support necessary to boost successful outcomes. Although empirical research is growing on the pivotal effects of support from faculty mentors, there are fewer numbers of theory-driven studies that examine the effects of their support (i.e., Jacobi, 1991; Maldonado et al., 2005; Phinney et al., 2011; Ragins & Cotton, 1999; Ragins & McFarlin, 1990; Weinstein, 1998). In contrast to mentors, there is even less research on the effects of informal support from program staff and peers in comprehensive interventions, or from extended family members outside of those intervention settings.

Strong Informal Support

Compared to formal organizational support, there is an even more substantial body of literature clarifying how informal social support from program staff, friends, or various family members promotes successful student and career outcomes (Baron & Kenny, 1986; Ebreo, 1998; Reyes, 2002). Guided by this literature, data collection for this study utilized several excellent informal social support measures to investigate how they might enhance intervention efficacy. For example, strong informal support from multiple sources both within and outside the intervention setting may provide UR students with multiple benefits or functions – aid (material assistance and guidance), advice (guidance and information), and affirmation (socio-emotional encouragement) – to promote their long-term success. Moreover, encouragement from multiple sources may also function to reduce the effects of role-related stressors and promote both short-term and long-term positive intervention outcomes (Baron & Kenny, 1986).

Social support research shows that perceived informal support promotes well-being and successful outcomes, especially under stressful circumstances (see e.g., Cohen, Underwood, & Gottlieb, 2000; Ebreo, 1998; House, Umberson, & Landis, 1988). In the context of comprehensive pipeline programs, several studies have documented the importance of informal support from faculty mentors to successful program outcomes (Davis, 2008; Davis, 2010; Strayhorn & Saddler, 2009).

These studies document the importance of informal advice, affirmation and aid from faculty mentors beyond the formal faculty-student relationship. It is also important to better understand how informal organizational support from pipeline intervention staff and peers may impact outcomes for participants, although few studies address this question. The presence of historically underrepresented populations in STEM is relevant to all levels of the academic

trajectory, from the undergraduate status to the professoriate. In advocating for ethnic and cultural diversity throughout the STEM research career trajectory, the interplay between social support factors and informal sources is highlighted, and the powerful role of program interventions such as faculty mentor, staff, and peers in STEM success outcomes.

Informal Faculty Mentor Support

With respect to social support orientations, there is a growing body of theoretical and empirical research on the importance of both formal and informal mentoring (Harris, 2002, 2013; Jacobi, 1991; Maldonado et al., 2005; Phinney et al., 2011; Ragins & Cotton, 1999; Ragins & McFarlin, 1990; Weinstein, 1998). While most research suggests that faculty-protégé mentoring is influential in countering student isolation in STEM (e.g., Astin, 1993; Seymour, 2001), other empirical findings are inconclusive.

Brown (2002) examined the faculty-student mentoring relationship using Seidman's (1998) in-depth interview technique. Brown analyzed data from Hispanic undergraduate science majors from a Southwestern four-year state institution, including their academic trajectory and success in a field heavily populated by ethnically underrepresented students. The results, which were similar to other findings in the literature, indicate that positive faculty-student interactions reinforce students' decisions to continue within their intended majors. Conditional on the faculty's "worldview" (Lynch, 1998, p. 133) or cultural perspective, the ability of faculty to relate or incorporate relevant cultural aspects of students' backgrounds into STEM education positively influences student success. In addition, study participants attributed their success in science to supportive instructors who influenced their learning and development. This finding supports Friedman and Kay's (1990) survey results indicating that non-minority faculty can be

instrumental collaborators for UR student success in STEM. Specifically, students who perceive the faculty to be helpful in their academics were reported to have positive grade performances.

There is evidence that this relationship is important for degree completion among UR students in STEM majors as well (Gloria, Castellanos, Lopez, & Rosales, 2005; Hernandez, 2000; Hernandez & Lopez, 2004; Leslie, McClure, & Oaxaca, 1998). Later research has suggested the relevance of diversity and cultural workshops offered in mentoring programs, such as The Puente Project, which focuses on first-generation Latino college students and is oriented toward enhancing instructional techniques that are sensitive to cultural differences. This advantageous approach to strengthening faculty and student interactions would likely be ideal for increasing UR students' success in STEM.

Although Friedman and Kay (1990) and Brown (2002) found a positive relationship between faculty-student interactions and STEM persistence, Seymour and Hewitt's (1997) findings pointed to student disappointment with similar interactions. Their analysis of a much-cited ethnographic study examined undergraduate students' reasons for leaving STEM disciplines. Of participants who switched away from STEM majors, 24% attributed their decision to inadequate faculty counseling, advice, or tutorial assistance, and 75% were frustrated by the inconsistency of faculty relationships. Non-switchers also indicated concern and dissatisfaction with their relationships with faculty by a slight majority, 52%. These findings suggest the lack of quality in faculty-protégé relationships, indicating that STEM faculty may have low expectations of students, especially UR students, which negatively affects their success and the low numbers of UR faculty in STEM. The lack of faculty availability for engaging in quality conversation with students and the absence of ethnic reflections in the academic classroom combine to discourage minority students who are pursuing a STEM degree (Morrison

& Williams, 1993). Hathaway, Sharp, and Davis (2001) employed institutional data on a "matched sample of 1st- and 2nd-year science and engineering students who had participated in the WISE-RP over four years (p. 111). Similar to their counterparts in the Meyerhoff program, WISE-RP participants had professional mentoring from science and engineering faculty.

Informal Program Staff Support

In addition to faculty mentors, program staff members also play a key role in the successful implementation of multifaceted interventions, providing aid, advice, and affirmation (Davis, 2007; Ebreo, 1998; Nocera & Harrison, 1996). In comprehensive interventions, program staff members are responsible for a variety of co-curricular activities and supplemental instruction, and provide critical informal support that promotes the full participation of women and minorities (Litton, Cohen, & Schlesinger, 2007; Thomas, 1985). Staff-facilitated sessions typically focus on addressing participants' preparation gaps, as well as providing content reinforcements including tutoring, collaborative learning, and general academic skills. Their work directly relates to programmatic features affecting student expectations and plans, academic preparation, examinations, and student application and admission. Students' opportunities for supportive interactions with program staff will have a positive effect on program satisfaction (Johnson, 2007; Armstrong & Thompson, 2003; Maton, Hrabowski, & Schmitt, 2000).

In an economically stressed time when most institutions of higher learning are considering drastic measures to reduce expenditures, support services are typically at the forefront for elimination. Higher education administrators are being questioned about the costs and benefits of comprehensive pipeline interventions, the continuing success of enrolled students, and degree completion. Therefore, we need to better understand the role of formal and

informal support from staff in comprehensive pipeline interventions in successful student outcomes.

Informal Program Peer Support

While researchers have examined the influence of peer-protégé mentoring on UR students in STEM, there also is a need to examine the effects of peer support and mentoring at the institutional level. According to Friedman and Kay (1990), UR students reported that the decision to persist in engineering was most influenced by interactions with friends and other peers. Research by Good, Halpin, and Halpin (2000) and by Marable (1999) further supports that viewpoint. Good and colleagues used qualitative data, in the form of journal responses from 19 upper-level peer mentors, to garner information on a peer mentoring program within a minority engineering program at a large land-grant university in the Southeast. They found evidence that peer mentors were positively impacted by the roles in which they served, specifically with respect to networking skills. In addition, peer mentors were beneficiaries of the program academically, professionally, and communicatively, in terms of their persistence in engineering.

On the other hand, Marable (1999) applied a similar qualitative methodology to the peer counseling and mentoring approach (Bolling, Novemsky, & Dios, 1988) to analyze the mentoring process at Tennessee Technological University's summer bridge program, the Precollege Initiative for Minorities in Engineering (PRIME). PRIME participants were all African Americans and recent high school graduates, who worked with undergraduate peer mentors on mathematics skills, engineering concepts, study skills, and personal and career development skills in order to establish a community of learners. Marable examined the mentoring dynamics from two cohorts of PRIME participants, seven students in total, and peer mentors attending the university's engineering program. His findings suggested that former

PRIME students felt more academically prepared as a result of their participation and that they valued their summer program experience, especially the impact of the peer mentors upon them. As a former PRIME student says: "They [peer mentors] were role models for us. When around us, they performed well. They taught me to be professional and to relax without stressing out over academics" (Marable, 1999, p. 52).

The PRIME study clearly shows the importance of students' perceived support from peers for persistence to a degree in engineering. However, the small sample size in this qualitative study points to the importance of additional research on the role of the various types of informal peer support – aid, advice and affirmation. Good, Halpin, and Halpin (2002) and Marable (1999) extend the concept of psychosocial support to further reinforce the importance of affirmation in peer mentoring services, which include peer interaction and supportive psychosocial affirmation, on students' motivation to succeed, especially in science-related fields (Cohoon & Aspray, 2006; Goodman, 2002).

Importance of Psychosocial Support: An Extension of Social Support as Informal Support

The informal social support literature highlights the particular importance of psychosocial affirmation in promoting successful outcomes across a wide range of situations (e.g., Allen, 1992; Baron & Kenny, 1986; Cohen et al., 2000). Overall, the effects of faculty, staff, and peer mentoring are conditional and vary depending on institutional characteristics, institutional policies such as those based on race and gender, additional support services, and students' background characteristics. Both material aid and advice or information-sharing can have a positive influence on students' success in STEM. However, psychosocial affirmation may be an especially important type of support in STEM pipeline interventions for UR students, who often must cope with discouraging barriers. Allen (1992) argues that psychosocial support may be the

most important factor for promoting successful outcomes, because it is instrumental in creating positive reinforcement systems.

In effect, psychosocial support may be a critical by-product of faculty, staff, and peer support and mentoring. Faculty mentoring has been found to provide positive affirmation and emotional support to mentees in several studies (Bowen & Bok, 1998, p. 203-204; Marable, 1999). Moreover, a comprehensive approach that utilizes staff leadership and peer role models within STEM interventions may enhance students' success by reinforcing social capital, trust, and psychosocial affirmation (Landis, 1995; Reichert & Absher, 1997; Stewart, 1990). According to Davis (1991), "the specific roles that support systems are believed to play include the maintenance of individual self-esteem and life satisfaction, increasing social and academic competence and environmental mastery, and the management of stress and coping" (p. 145).

Psychosocial affirmation from faculty has proven to be especially essential in boosting a student's self-confidence in STEM pursuits (Bowen & Bok, 1998; Marable, 1999; Morrison & Williams, 1993). This type of faculty-student interaction may be especially significant for STEM majors because it helps to counter isolation and promote a sense of belonging, positive identity, and self-esteem. The adverse effects of isolation among UR students are further exacerbated by the low numbers of UR faculty, and the general lack of faculty time to engage in quality conversation with students (Morrison & Williams, 1993). The need for psychosocial affirmation may be especially important for UR students who enter STEM pipeline interventions from predominantly white institutions. The lack of diversity in classrooms may create an absence of supportive ethnic reflection in the learning environment, which deters these students from pursuing a STEM degree. Thus, the adverse effects of such student isolation on successful STEM outcomes may be reduced by interventions that provide psychosocial affirmation not only from

faculty, but also from supportive program staff and peers. Such informal support from multiple sources may further socially integrate UR students into STEM academic disciplines and promote successful outcomes (Brown, 2002; Friedman & Kay, 1990; Good, Halpin, & Halpin, 2002; Hathaway, Sharp, & Davis, 2001; Maton, Hrabowski, & Schmitt, 2000; Seymour & Hewitt, 1997).

Policy-Relevant Ethnic and Gender Differences

This study focuses on the critical policy-relevant issue: Are there gender by ethnicity differences among pipeline intervention participants regarding how they experience the multiple components of formal organizational support? Such gender by ethnicity comparisons are especially critical to achieving a better understanding of UR students and other sub-groups who are of interest to policy makers, as they may face qualitatively different types of inequality (Blake-Beard, Bayne, Crosby, & Muller, 2011; Hesler & Hesler, 2002; Settles, Cortina, Stewart, & Malley, 2007). Campus-based STEM pipeline interventions that targeted specific race and gender subgroups were common prior to the national crusade to abolish them. However, we still need to understand the unique experiences of race-by-gender subgroups within the increasingly diverse populations involved in pipeline programs at all levels.

For example, Clewell and Campbell (2002) suggest that although women in general face barriers to equality in STEM fields, UR women are even more marginalized and may face unique formal and informal organizational support challenges. Robinson (2009) followed up with research on female students who utilized math-tutoring services at a campus-based residential learning center, demonstrating that these services positively affected students' major choice in math- and science-related fields and their rates of persistence. Other researchers (Good, Halpin,

& Halpin, 2002; Perna et al., 2009) have explored how academic intervention programs increase participation for both high-achieving and at-risk UR students in the science pipeline.

Student Role Stress, Adaptive Strengths, and the Buffering Hypothesis

As outlined in the conceptual model, this study also explores whether or not the effects of SROP *formal and informal* organizational support on successful STEM outcomes are stronger among UR students facing role stress (e.g., overload, conflict, or ambiguity). Student role stress refers to the objective barriers often faced by UR students, such as status-related, economic, and academic barriers, and the related subjective threats, such as stereotype threat, financial stress, and academic discouragement (e.g., low grades), that increase risky coping behaviors and impede successful outcomes (Bowman, 2006, 2011a, 2013; Steele, 1997). Role adaptation is the related process through which resilient UR students mobilize support within pipeline interventions and adaptive personal strengths (e.g. personal resiliency, extended family networks, and faith-based engagement) to empower more achievement-related coping and successful outcomes. Related theoretical and empirical literature suggests that UR students who experience high levels of role stress are also more likely to face a related stress-buffering challenge (Baron & Kenny, 1986; Bowman, 2006, 2011a, 2013). That is, the achievement of a successful outcome is more likely to depend on organizational support to buffer the deleterious effects of high levels of role strain and organizational stress. When these students face high role strain, they are also more likely to face organizational stress and to depend on informal support from multiple sources in order to overcome the interrelated role barriers, threats, and stress. As illustrated in the conceptual model, the strengths-based model guiding this study explicates the nature, context, and consequences of student role stress which is systematically exacerbated by structured status inequalities often faced by UR students.

Among UR students participating in exemplary interventions, there are hypothesized pathways among inequality, role stress, adaptive strengths, coping processes, and successful program outcomes (Bowman, 2006, 2011a, 2013). Within this model, the deleterious impact of role stress can be exacerbated by multilevel risks but reduced by exemplary interventions and adaptive strengths. In general, there are two basic theoretical propositions regarding role strain. First, structured inequalities systematically combine with chronic role strain, psychosocial stressors, and risky coping strategies to impede successful program outcomes. Second, despite role strain, exemplary interventions and multilevel strengths can promote personal resiliency, more achievement-related coping strategies, and successful program outcomes. Hence, the impact of exemplary interventions, adaptive multilevel strengths, and role strain processes on successful program outcomes may be mediated by differential modes of coping among UR students – adaptive or risky. This focus on the importance of stress and coping among UR students is based upon theoretical and empirical research with a particular emphasis on the pivotal stress-buffering role of strong social support and adaptive multilevel strengths (Burke, 1996; House, 1974; Kaplan, 1996; Pearlin, 1983, 1989). According to White (1974), "coping has acquired a variety of conceptual meanings, being commonly used interchangeably with such kindred concepts as mastery, defense, and adaptation" (as cited in Pearlin & Schooler, 1978, p. 2).

Student role stress is measured here by applying a standard scale that taps three critical dimensions of role stress – role overload, conflict, and ambiguity (Bernhard, 1996; Coverman, 1989; Kelloway & Barling, 1990; Kahn & Byosiere, 1992; King & King, 1990; Tracy & Johnson, 1981). These concepts are especially significant for African American, Latina/o, American Indian, and other UR students who not only face normative challenges such as

competitive academic demands, as other students do, but also non-normative obstacles to college and career success associated with race-, ethnic-, and class-related disadvantages (Neville, Heppner, & Wang, 1997; Pritchard et al., 2007; Steele, 1997). Therefore, expected SROP benefits for many UR students may be systematically constrained by non-normative student role barriers, threats, and organizational stress, while being facilitated by organizational support and adaptive personal strengths that promote achievement-related coping (Bowman, 2006, 2011a, 2013; Hurtado et al., 2007; Lopez, 2005; Orellana & Bowman, 2003).

Role Stress and Adaptation Moderators of Intervention Efficacy

Role stress is experienced by most UR students as a by-product of an accumulation of educational gaps in their academic trajectory. This often can stem from role strain, role conflict, role overload, role ambiguity, and incongruent perceptions between the student and faculty members at institutions of high learning (Thiry, Laursen, & Hunter, 2011). Research has shown that role stress is associated with role strain, such as minority or gender status, in higher education (Smedley, Myers, & Harrell, 1993; Saldaina, 1994; Mallinckrodt & Leong, 1992), as well as with role conflict, such as student-faculty academic relationships, power dynamics, absence of student's voice, and the reentry experience for non-traditional students (Gilbert, 1980; Home, 1998; Jamieson & Thomas, 1974; Mallinckrodt &Leong, 1992; Settles, Cortina, Stewart, & Malley, 2007). In addition, student role stress is associated with role overload, such as multiple responsibilities. For example, UR students may face the pressure to maintain full-time status at college while working to pay for tuition and family responsibilities (e.g., Rich, 2007). Lastly, role stress is associated with role ambiguity, such as uncertainty about expectations and strategies when faculty, staff, or peers do not provide adequate guidance (Rizzo, House, & Lirtzman, 1970; Hansen & Birden, 2006).

In a study that included semi-structured interviews with 62 graduating undergraduate seniors, Thiry, Laursen, and Hunter (2011) found that research experiences were not only a source of positive gains toward STEM successful outcomes but also a source of negativity; their problematic experiences reflect clear links among student role stress, ambiguity, and negative outcomes:

> Most negative statements came from a small subset of students whose poor research experience had caused them to change their career and educational plans. These research students were given little or no direction on their research activities, felt no sense of responsibility over a project, and often had mentors who were unavailable or too busy to provide adequate guidance. (p. 377)

Within comprehensive pipeline interventions, both strong organizational support and adaptive strengths among UR students themselves may help to combat such role stressors by promoting more active coping strategies and successful outcomes.

Adaptive Student Strengths: Moderator or Buffer Effects

Some strengths-based studies suggest that UR students may possess cultural strengths that enable them to cope in more adaptive ways despite discouraging role barriers and stress (Bowman, 2006, 2011a, 2013; Hrabowski et al., 2002; Hrabowski et al., 1998). Three types of adaptive student strengths focused on in the present study are personal resilience (John Henryism), extended family networking, and faith-based community engagement (e.g., James, 1993; Reyes, 2002; Cunningham, 1984). These adaptive strengths promote more active coping which involves an awareness of the stressor, followed by attempts to reduce its negative or maladaptive impact on the outcome. Using a cultural or emic perspective instead of a universal or etic perspective on the value of strong pipeline interventions thereby highlights the importance

of utilizing more culturally responsive practices related to adaptive strengths from the outset for increasing a culturally diverse STEM workforce.

Personal Resiliency: John Henryism, a measure of personal resilience originally developed for studying African American men, is a "construct which describes an individual's self-perception that they can overcome the demands of their environment through hard work and determination" (Benn et al., 2014; James, 1993). For example, although a number of studies have associated John Henryism with high blood pressure in African American men (Adams, Aubert, & Clark, 1999; Clark & Adams, 2004; Fernander, Duran, Saab, & Schneiderman, 2004; James, Hartnett, & Kalsbeek, 1983; James, LaCroix, Kleinbaum, & Strogatz, 1984; Merritt et al., 2004), there is a recent trend of studies associating this active coping orientation with the Model Minority construct typically linked to Asian Americans (Hsieh et al., 2014; Yim, 2009). Within higher education, several studies have demonstrated the value of summer undergraduate research experiences (e.g., Trent & Gong, 2006) but, unfortunately, few studies focus on adaptive strengths similar to John Henryism (e.g., Moore, Madison-Colmore, & Smith, 2003; Russell & Atwater, 2005).

Extended Family Support and Cultural Strengths: A growing number of researchers emphasize the importance of better understanding the role of extended family networks and related cultural strengths in the successful outcomes of African Americans and other UR students (Bowman, 2013; Hill, 1999; Reyes, 2002; Taylor, Chatters & Levin, 2004). For example, Hill (1999) documents the important role of five intergenerational family strengths among African Americans – strong extended kinship bonds, strong work orientation, flexible family roles, strong religious orientation, and strong achievement orientation. A few researchers already have shown that family support, demonstrated by the act of students having early family socialization

to STEM, generally results in students pursuing STEM disciplines and careers (Leslie, McClure, & Oaxaca, 1998). Parental support in areas such as STEM major and career choice has an impact on college persistence in the pursuit of career plans (Grandy, 1998; Herndon & Hirt, 2004; Fries-Britt, 2000; Weidman, 1984). UR students in several STEM intervention studies noted the importance of having supportive mothers who were involved in their day-to-day lives, including the home environment, encouragement, and expectations (Brown, 2002; Hrabowski, Maton, & Greif, 1998; Maton & Hrabowski, 2004; Moore, 2005; Russell & Atwater, 2004). Rendon (1994) found that interpersonal validation from faculty, friends, parents, and siblings had a strong effect on general persistence and pursuit of career plans for UR students.

Within STEM intervention research, comprehensive strengths-based studies have found that a family-like sense of community (Kendricks & Arment, 2010; Maton, Hrabowski, & Ozdemir, 2007; Maton & Hrabowski, 2004) functions as a supportive extra-familial network (Portes, 1998) and is especially important for enhancing UR students' success in STEM. Kendricks and Arment (2010) found that students who participated in Central State University's Benjamin Banneker Scholars Program (BBSP) and received strong support from its family model, coupled with an undergraduate research experience, were more likely to have an increase in academic performance in STEM. Strengths-based descriptions of the exemplary Meyerhoff Scholars Program also have emphasized the importance of mobilizing a wide range of African American family and cultural strengths to promote successful STEM outcomes among both males and females (Hrabowski, Maton, & Greif, 1998; Hrabowski, Maton, Greene & Greif, 2002). However, few studies have systematically investigated cultural strengths such as extended family networks and faith-based community engagement among UR students in summer

undergraduate research programs and the possible linkage to participation and pursuit of STEM research careers.

CHAPTER III

METHODOLOGY

This study investigated how exemplary pipeline interventions, formal organizational support, informal organizational support, role stress, and adaptive strengths influence STEM research career plans among participants. Two primary aims were associated with this study. The goal of Aim 1 was to continue building on a comprehensive strengths-based framework, and to develop reliable and valid measures of strong formal and informal organizational support that will be useful for research with UR college students in summer research pipeline interventions. The goal of Aim 2 was to explore how these organizational support measures may help to explain successful STEM outcomes among students. This chapter begins with a presentation of the research design and rationale for the study. Next the setting and sample are described, followed by a discussion of the measures used in the study. The chapter concludes with a discussion of how the data were analyzed. The data analysis section presents the following: (1) each research aim, (2) the research questions associated with each aim, and (3) the statistical procedures that were used to address each research question.

Panel Survey Research Design

This panel survey research design used data collected at three time points to address the major research aims and questions. The panel data for this study were a subset of longitudinal data collected for a broader mixed-method study funded by the National Institute of General

Medical Sciences at the National Institutes of Health. The overarching study was titled "A Multimethod Study of Exemplary Research Opportunity Interventions," and the principal investigator was Dr. Phillip J. Bowman at the University of Michigan. I worked as a member of the research team that collected the panel survey data selected for this study from undergraduate students who applied to the Committee on Institutional Cooperation's Summer Research Opportunity Program for the summer 2011 program session.

Socio-demographic and other background data were initially collected during the summer of 2011 (Time 1). Students were surveyed again in the fall of 2011, directly following the intervention, to collect data on their experiences in the program including assessments of formal and organizational support experiences (Time 2). Finally, students were surveyed again in spring 2012 with a particular focus on outcome measures including STEM research career plans (Time 3). The panel survey instruments used at each point in time were carefully designed and pre-tested, with preliminary analysis conducted to further refine questions and measures.

Research Setting and Sample

The data for this analysis comes from the CIC-SROP which was initiated in 1986 and is currently active at various universities within the Committee on Institutional Cooperation. The following CIC institutions agreed to participate in the current study: 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.) As an academic consortium, CIC has a range of strategic priorities including goals for the SROP to increase the number and diversity of students who attend

graduate school and pursue research careers. CIC-SROP was structured to meet the needs of students who are underrepresented in graduate education. It targets second- and third-year students expressing interest in pursuing a Ph.D. Since its founding this program has served over 9,000 students.

Research Variables and Measures

Several measures were used to collect the data for this study. In this section I describe each of the measures. I begin by discussing the dependent or outcome variables. I then discuss the independent or predictor variables. I include a description of each variable and the measures that were used to collect data on each.

Major Dependent and Outcome Variables

Two variables were used as dependent outcomes in this study. Those two variables included overall program satisfaction and STEM research career plans. Sections below describe each of the dependent variables. The material also discusses how data was collected for each variable and how the scores were calculated.

***Overall Program Satisfaction*.** Students were asked to rate their satisfaction with their experiences in the summer program. Single items served as measures of overall program satisfaction. Students who participated in the CIC-SROP replied to the question, "How satisfied were you with each of the following formal program components offered by your SROP host campus?", while students who participated in some other summer research experience replied to a similar question, "How satisfied were you with each of the following components offered with your research experience?" The scale for both questions was 1 = *not satisfied at all*, 2 = *somewhat satisfied*, 3 = *very satisfied*, and 4= *extremely satisfied*. On the original measures, a lower score indicated a higher level of satisfaction. For consistency, both measures were recoded

so that higher scores would indicate higher levels of satisfaction. Participants also were asked to rate the likelihood that they would recommend the program to someone else. The rating for that item used a 5-point subjective probability scale: 1 = *definitely no*, 2 = *probably no*, 3 = *maybe*, 4 = *probably yes*, 5 = *definitely yes*.

STEM Research Career Plans. A single item was used to assess students' research career plans. These responses were measured on a 5-point Likert-type scale that ranged from 1 = *completely certain I will not pursue a STEM research career* to 5 = *completely certain I will*. On the original measure, a lower score indicated a higher certainty about pursuing a STEM research career. For consistency, the measure was recoded so that higher scores would indicate higher levels of certainty. This type of 5-point subjective probability item can be treated as a continuous variable in regression analysis (e.g., Johnson & Creech, 1983; Zumbo & Zimmerman, 1993).

Major Independent and Predictor Variables

The independent variables used in this study pertained to the broad categories of social and demographic characteristics, program intervention, strong formal and informal organizational support, role stress, personal resiliency, extended family support, and faith-based community support. The following is a description of how data were collected and scores were computed for each variable.

Socio-Demographic Background and STEM Major. Table 3.1 presents a summary of selected socio-demographic characteristics of the survey sample. Results from the chi-square analysis show that there were no statistically significant differences in socio-demographic characteristics between UR students who participated in CIC-SROP and OSROP interventions.

Table 3.1: Socio-Demographic Characteristics of the Research Participants by Program Participation (OSROP vs. CIC-SROP)

Variable	OSROP (%)	CIC-SROP (%)	Total (%)	Chi Square p-value
Gender				.95
Female	41 (67%)	322 (67%)	363 (67%)	
Male	20 (33%)	160 (33%)	180 (33%)	
Total	61 (100%)	482 (100%)	543 (100%)	
Race/Ethnicity				.30
White/Other/Asian/Hawaiian Pacific Islander	28 (45%)	98 (25%)	126 (28%)	
Black, Hispanic/Latino(a), Alaskan/American Indian	34 (55%)	287 (75%)	321 (72%)	
Total	62 (100%)	385 (100%)	447 (100%)	
The highest number of years of school completed by mother				.44
High School Grad/or Less	17 (33%)	102 (29%)	119 (29%)	
Some college	11 (21%)	77 (22%)	88 (22%)	
Four year degree (e.g., BA, BS)	18 (35%)	92 (26%)	110 (27%)	
Master's degree (e.g., MA, MS)	5 (10%)	59 (17%)	64 (16%)	
Doctoral degree (e.g., PhD, MD)	1 (2%)	21 (6%)	22 (5%)	
Not sure	0 (0%)	5 (1%)	5 (1%)	
Total	52 (100%)	356 (100%)	408 (100%)	
The highest number of years of school completed by father				.67
High School Grad/or Less	21(41%)	119 (34%)	140 (35%)	
Some college	8 (16%)	66 (19%)	74 (18%)	
Four year degree (e.g., BA, BS)	13 (26%)	72 (20%)	85 (21%)	
Master's degree (e.g., MA, MS)	7 (14%)	51 (14%)	58 (14%)	
Doctoral degree (e.g., PhD, MD)	1 (2%)	33 (9%)	34 (8%)	
Not sure	1 (2%)	14 (4%)	15 (4%)	
Total	51 (100%)	355 (100%)	406 (100%)	
STEM Major				.66
Yes	34 (62%)	288 (65%)	322 (65%)	
No	21 (38%)	156 (35%)	177 (36%)	
Total	55 (100%)	444(100%)	499 (100%)	

It is interesting to note that a large portion of the UR students in both CIC-SROP and OSROP were female, historically underrepresented minorities, first-generation college students (with mothers and fathers who were high school graduates or less with no college attendance), and STEM majors.

Two policy-relevant socio-demographic characteristics, gender and race/ethnicity, were considered to be crucial in this study of UR students in summer research pipeline interventions. Gender was measured as a dichotomous variable (1 = male, 0 = female). In accordance with standard racial/ethnic classifications used by the United States Census, students were asked two questions: "Are you of Hispanic, Latino, or Spanish origin?", and "With which racial/ethnic/cultural background do you primarily identify?" The response options were: 1 = African American/Black/Negro, 2 = American Indian or Alaskan Native, 3 = Asian American, 4 = Native Hawaiian/Other Pacific Islander, 5 = White or Caucasian, and 6 = Other. Responses from the first question were used to distinguish among students who identified as non-White. Students who identified as "Hispanic" in the first question and "Other" in the second were coded as Hispanic/Latino (a) in this research. Once the respondent's racial/ethnic/cultural group was identified, a dichotomous variable was created to identify underrepresented students of color as mostly categorized in STEM literature: 0 = White, Asian American, Native Hawaiian/Other Pacific Islander, and Other; 1 = African American/Black/Negro, American Indian/Alaskan Native, and Hispanic/Latino (a) (Williams, 2014). Similarly to socio-demographic characteristics, STEM major was coded as a dichotomous variable where self-identified biomedical/behavioral sciences, and other basic or applied sciences majors are considered STEM majors (1 = STEM major) and all others are considered non-STEM majors (0 = non-STEM) (Williams, 2014).

Intervention Participation. The CIC-SROP students were identified using administrative data about program participants at each of the CIC host campuses. OSROP students were classified from self-reports of those who applied to CIC-SROP, but did not participate for some reason; these students indicated that they had participated in a summer research opportunity program other than CIC-SROP. A dichotomous intervention strength variable was created that represents: (1) CIC-SROP participation with a strong multi-component design, or (2) OSROP participation without a clear multi-component design.

Strong Formal Organizational Support Items. Strong formal organizational support items were developed specifically for this study based on core themes from related literature on strong pipeline interventions and an extensive review of CIC-SROP archival information (e.g., Davis, 2006; Maton & Hrabowski, 2004; Trent & St. John, 2008). In consultation with CIC-SROP officials, an earlier version of this measure was pretested and refined for this study to tap student engagement with the multiple components and resources provided by CIC-SROP and other pipeline interventions with a strong program organization. The instrument was originally conceptualized to contain five measures representing major CIC-SROP program components. Table 3.2 presents the 17 specific items comprising the Strong Formal Organizational Support scale, divided into five hypothesized conceptual measures: Supervised Research Project, Financial Aid, Graduate Studies Planning, Faculty Research Career Development, and Strategic Networking Opportunities.

Table 3.2: Strong Formal Organizational Support Items Representing Program Components

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I. Supervised Research Project
1. Research project with faculty mentor
2. Regular meetings with faculty mentor
3. Scheduled meetings with SROP advisors/staff
4. Scheduled meetings with SROP peer mentors
5. Sessions or presentations on research project writing

II. Financial Aid
6. Financial support including your SROP stipend and travel expenses
7. Campus resources including your housing and facilities

III. Graduate Studies Planning
8. GRE exam preparation course
9. Sessions on applying to graduate school
10. Sessions on funding for graduate studies
11. Sessions on life as a graduate student
12. Opportunities for oral and written research project presentations

IV. Faculty Research Career Development
13. Opportunity to observe faculty as role model
14. Opportunities to interact with graduate students
15. Presentations on how to talk about my research

V. Strategic Networking Opportunities
16. Formal opportunity for personal development
17. Formal opportunity for social networking

Strong Informal Organizational Support Items. With a focus on these multiple measures, three scales were utilized in the present study to also assess the major sources of informal organizational support in strong pipeline interventions: program mentors, staff, and peers. The Strong Mentor - Informal Organizational Support scale included 30 items which assessed participants' perceptions of support available from faculty mentors during the program. The Cronbach's alpha for the Strong Mentor Support scale indicated a high reliability ($\alpha = .97$)

and was at a level consistent with previous research using similar scales (e.g., Ebreo, 1999). The Strong Staff - Informal Organizational Support scale referred to 30 items that assessed perceptions of support available from program staff while attending a summer research program (the $\alpha = .97$ Cronbach's alpha for the Strong Staff Support scale indicated a high reliability). The Strong Peers - Informal Organizational Support scale also included 30 items, which assessed participants' perceptions of support available from their program peers. Cronbach's alpha calculated for this scale was also highly reliable ($\alpha = .98$). Respondents answered each of the items using a 5-point Likert-type scale of 1 = *definitely yes* to 5 = *definitely no*. In calculating scale means, items were recoded such that higher scores indicated stronger perceptions of faculty, staff, and peer informal organizational support. A complete list of items for the Strong Informal Organizational Support Measure can be found in Appendix A.

Student Role Stress. Based on organizational perspective, role stress was assessed by a 26-item Student Role Stress Scale designed to determine individuals' perceptions of distress as a student (Bernhard, 1996). This measure was adapted from a standard theory-driven scale that assesses three critical dimensions of student role-related organizational strain: role overload, role conflict, and role ambiguity (Coverman, 1989; Kelloway & Barling, 1990; Kahn & Byosiere, 1992; King & King, 1990; Tracy & Johnson, 1981). Participants responded to each of the 26 items using a 5-point Likert-type scale: 1 = *never*, 2 = *almost never*, 3 = *sometimes*, 4 = *fairly often*, and 5 = *very often*. This scale showed a high Cronbach's alpha value of .88 (Bernhard, 1997, p. 112).

The role overload subscale is composed of eight items which assessed the students' perceptions of how much overload they experienced due to various course assignments (e.g., "I have too many projects and assignments to perform"). The original subscale showed high

internal consistency in a previous study (α=.84) (Bernhard, 1997, p. 112). The present research found good internal consistency reliability with a Cronbach's coefficient alpha of .75.

The role conflict subscale had ten items evaluating students' perceptions of the degree to which they experienced competing demands from their classes (e.g., "I have two or more classes which operate quite differently"). Previously reported values of Cronbach's alpha for the scale (α= .73) indicated that it is reliable (Bernhard, 1997, p. 112). In the present study a Cronbach's alpha value of .76 was obtained.

The role ambiguity subscale included eight items regarding students' perceptions of the lack of clarity about expected behaviors or norms regarding the requirements for course assignments (e.g., "Course assignments/tasks are unclear to me"). Similarly, the original role ambiguity subscale has shown high internal consistency (α =.73) in Bernhard (1997, p. 112). The current study also found good internal consistency with a Cronbach's coefficient alpha of .85.

Scores for each scale were calculated by taking the average of the scores for each related item assigned. Higher numbers represent greater levels of student role stress. The text of the items comprising the scales of the Role Stress Measure can be found in Appendix B.

Personal Resilience. To measure personal resilience, a John Henryism active coping scale was employed that not only shows high levels of reliability, but has been shown to be especially useful in research on African Americans and other populations faced with systematic life barriers (e.g., James, 1993; James, Hartnett, & Kalsbeek, 1983). It is interesting to note, in addition to males, this scale also has shown utility for females as illustrated through the symbolic representation of Sojourner Syndrome (Mullings, 2002) and modified from the John Henryism scale (James, Hartnett, & Kalsbeek, 1983). The measure contained 12 items that represent hard work and determination despite obstacles and oppressive circumstances. Participants responded

to the items using a 4-point scale (1 = *completely fals*e, 2 = *mostly false*, 3 = *mostly true*, and 4 = *completely true*).

Extended Family Support. To assess the impact of students' extended family support on their successful STEM outcomes, this study utilized items modified from a scale originally employed by Reyes (2002). Fifteen items asked about the level of supportiveness various extended family members (e.g., "female cousin you feel closest to") would provide to participants in pursuit of the Ph.D. degree. Participants responded to the items using the 5-point scale 1 = *does not apply*, 2 = *extremely supportive*, 3 = *very supportive*, 4 = *somewhat supportive*, and 5 = *not at all supportive*. The total score on the scale was computed by adding the scores for each item and dividing by the total number of items. For consistency, the measure was recoded so that higher numbers on the scale represented greater levels of extended family support. This study found good internal consistency reliability with a Cronbach's coefficient alpha of .84. A complete list of items for the Adaptive Strengths Measure appears in Appendix C.

Faith-Based Community Engagement. Based on a review of related literature, I developed a 4-item index to assess faith-based community engagement. This related literature suggests that these items represent a source of adaptive cultural strength among African Americans, Latinos, and other people of color (Cunningham, 1984; Jennings & Clarke, 2008; Taylor, Chatters, & Levin, 2004). The first item focuses on the ethnic composition of the student's place of worship (if they attend religious services or activities). Students were asked to indicate whether the attendees at their place of worship consist of all or almost all persons of their ethnic group; mostly persons of their ethnic group; about half of their ethnic group and half other ethnic groups; mostly persons of other ethnic groups; or all or almost all persons of other

ethnic groups. This item was coded so that higher numbers represent a place of worship that consists of persons of similar ethnicity.

Responses to the other three items on the index were collected using a 5-point scale, where 1 = *very strongly agree* and 5 = *very strongly disagree*. Responses to these items were subsequently recoded so that larger numbers correspond to greater levels of faith-based engagement. Research participants were asked to indicate their level of agreement with the following statements: (1) I consider myself a very religious person; (2) I pray on a regular basis – daily or whenever I get a chance; and (3) I attend church or religious services regularly – weekly or whenever I get a chance. The total score on the scale was computed by adding the scores for each item assigned to each scale and dividing by the total number of items assigned to each. In the present study a Cronbach's alpha value of .91 was obtained.

Data Analysis Techniques

Several statistical procedures were used to analyze the data collected in this study, as determined by the research aims and the related research questions. This section outlines the two research aims, the research questions associated with each aim, and the statistical procedures that were conducted to address the research questions. When conducting quantitative data analysis, a key step in the process is to prescreen the data to assess its accuracy and validity before any statistical procedures are performed (Harris, 2013; Mertler & Vannatta, 2005). Appendix E provides details regarding the prescreening procedures used to address the two major research aims and related questions. Results indicated that no adjustments were made to the data.

Research Aim 1: Strengths-Based Measurement Development

The first aim of this research was to build on a comprehensive strengths-based framework to develop reliable and valid measures of strong formal and informal organizational

support that are useful for conducting research on traditionally underrepresented minority (URM) students who attend summer research undergraduate pipeline intervention programs. The overarching research question associated with Research Aim 1 was: Can strong pipeline interventions in the form of formal and informal organizational support be measured with reliable scales that include empirically distinguishable subscales representing multiple components? Four research questions were associated with achieving this aim. Appropriate statistical procedures were used to address each of these four research questions, the details of which are presented below.

Research Question 1a. Research Question 1a: Are there significant *gender and ethnic differences* among pipeline intervention participants on specific items designed to measure the multiple components of *formal* organizational support? The objective of the first research question was to assess whether gender and ethnicity combined to differentiate pipeline intervention participants' perceptions of the various elements of formal organizational support. A series of 2 X 2 (gender X ethnicity) analyses of variance (ANOVAs) was conducted to explore policy-relevant comparisons on specific formal organizational support items. In Appendix E, I summarized several assumptions that were carefully considered before conducting ANOVAs for the present study.

Research Question 1b. Research Question 1b: Do UR students in the more strongly designed CIC-SROP programs actually perceive higher levels of *formal* organizational support than do UR students in other pipeline interventions (OSROPs) with fewer *formal* program components? With a focus on two-group comparisons, a series of independent samples t-tests was used to explore differences between UR students in CIC-SROP and in OSROP on the items assessing satisfaction with the five components of formal organizational support. Preliminary

examinations of the major assumptions for these t-tests are summarized in Appendix E to demonstrate the appropriateness of using the tests to make the group comparisons. As a preliminary step, undertaken before the analyses focused on the five formal support components, differences between the two sets of intervention groups on overall program satisfaction were examined. Consistent with the definition of strong organizational support, I hypothesize that students who participate in the CIC-SROP (which has a greater number of formal program components) will be more satisfied with the overall program than students who participate in OSROPs.

Research Question 1c. Research Question 1c: In addition to *formal* organizational support, do UR students in SROP interventions also benefit from *strong informal organizational support* from three major program sources – *faculty mentors, staff and peers*? Repeated measures ANOVAs were run to assess differences across the three major program sources on the 30 items that tap levels of informal organizational support on multiple factors - aid, advice, and affirmation.

Research Question 1d: Research Question 1d: Can strong *formal and informal* organizational support within pipeline intervention be measured with *reliable and valid scales* that include empirically distinguishable subscales representing multiple components? Can *formal* organizational support scales and subscales help to better clarify *meaningful differences* between strong CIC-SROP and other SROP interventions? What are the relationships between the *subscales* of formal and informal organizational support? Is there a significant relationship between strong *formal and informal* organizational support *scales*? To address these measurement development issues, factor analysis was employed to further clarify the multiple dimensions of strong formal and informal organizational support. Exploratory factor analysis

was utilized to examine the degree to which theory driven (observed) factors emerged as empirically-derived latent (hidden) constructs among the items selected to measure formal and informal organizational support within pipeline interventions.

A series of exploratory factor analyses was conducted for each formal and informal organizational support scale, followed by related psychometric analyses to further establish the reliability and meaningfulness of scales and subscales. As summarized in Appendix E, four primary methodological issues were considered in reaching the decision to use exploratory factor analysis.

Research Aim 2: Strengths-Based Predictive Relationships

With a focus on predictive relationships, hierarchical multiple regression was the primary analysis technique used to explore how strong formal and informal organizational support may help to explain overall program satisfaction and successful STEM research career plans among UR students in summer research pipeline interventions. First, hierarchical multiple regressions were employed to analyze data to address ***Research Question 2a***: In addition to objective pipeline intervention participation, do *formal and informal* organizational support factors further enhance program satisfaction and successful STEM outcomes? Second, moderated hierarchical multiple regressions with stress by support interaction terms were utilized to address ***Research Question 2b***: Are the effects of *formal and informal* organizational support on successful STEM outcomes stronger among pipeline intervention participants facing higher student role stress? Finally, moderated hierarchical multiple regressions were used to address ***Research Question 2c***: In addition to strong organizational support, do "adaptive strengths" among pipeline intervention participants help to buffer any deleterious effects of role stress on their successful STEM outcomes? In Appendix E, the specific procedures, are summarized that were used to prescreen

data before the hierarchical regression analyses were performed, and the ways in which the assumptions underlying this multivariate technique were addressed are summarized. (see Appendix D for the empirically worded research questions.)

CHAPTER IV

RESULTS

This chapter explores how organizational support in pipeline interventions combines with student role stress and adaptive student strengths to affect students' plans to pursue a research career in some STEM field. Results are presented in two sections organized around the major research aims and related questions. First, Strengths-Based Measurement Development focuses on the four specific questions related to **Research Aim 1:** Building on a comprehensive strengths-based framework, develop *reliable and valid measures* of strong formal and informal organizational support that are useful for research on UR undergraduate students in summer research pipeline interventions. Second, the Strengths-Based Predictive Relationships section presents findings that address the three specific questions related to **Research Aim 2:** Explore how strong formal and informal organizational support measures may help to explain overall program satisfaction and successful STEM outcomes among UR students in summer research pipeline interventions.

Research Aim 1: Strengths-Based Measurement Development

This section presents the results related to the four measurement development questions: (1a) Are there significant *gender and ethnic differences* among pipeline intervention participants on specific items used to measure the multiple components of *formal* organizational support? (1b) Do UR students in the more strongly designed CIC-SROP programs actually perceive

higher levels of *formal* organizational support than UR students in other pipeline interventions (OSROPs) with fewer *formal* program components? (1c) In addition to *formal* organizational support, do UR students in SROP interventions also benefit from *strong informal organizational support* from three major program sources – *faculty mentors, staff, and peers*? (1d) Can strong *formal and informal* organizational support within pipeline interventions be measured with *reliable and valid scales* that include empirically distinguishable *subscales* representing multiple components? Can *formal* organizational support scales and subscales help to better clarify *meaningful differences* between strong CIC-SROP and OSROP interventions? Is there a significant relationship between strong *formal and informal* organizational support *scales*?

1a: Strong Formal Organizational Support Items: Gender and Ethnic Differences

With a focus on policy-relevant comparisons, a series of 2 X 2 (gender X ethnicity) analyses of variance (ANOVAs) was conducted to explore policy-relevant comparisons on five categories of informal organizational support items. Table 4.1 presents these results. Gender and ethnic comparisons are presented for the 17 Strong Formal Organizational Support items within the five hypothesized conceptual categories: Financial Aid, Supervised Research Project, Graduate Studies Planning, Faculty Research Career Development, and Strategic Networking Opportunities. The differences on two measures of Overall Program Satisfaction also were explored. ANOVA findings for the main effects of gender are presented first, followed by the main effects of ethnicity, and the ethnicity by gender interaction effect.

The results show that using the adjusted critical value of $p \leq .01$, there were no statistically significant gender differences in participants' ratings on the Formal Organizational Support or Overall Program Satisfaction items. There were two formal organizational support items, Scheduled Meetings with SROP Advisors/Staff and GRE Exam Preparation, where the

Table 4.1: Formal Organizational Support and Overall Program Satisfaction Items, Means,and ANOVAs Across Gender and Race/Ethnicity

	Non-Underrepresented Groups (White/Other/Asian/ Hawaiian Pacific Islander)		Traditionally Underrepresented Minorities (Black, Hispanic/Latino(a)/ Alaskan/American Indian)		Main Effect	Main Effect	Interaction Effect
Formal Organizational Support Items	Female (N=90) Mean (*SD*)	Male (N=47) Mean (*SD*)	Female (N=126) Mean (*SD*)	Male (N=60) Mean (SD)	Gender *F*(Sig.)	Race/ Ethnicity *F*(Sig.)	Gender X Ethnicity *F*(Sig.)
1. Financial Aid							
a. Financial support including your SROP stipend and travel expenses	2.91 (1.46)	3.17 (1.06)	3.38 (.96)	3.50 (.78)	1.74 (.19)	11.5 (.00)**	.25 (.62)
b. Campus resources including your housing and facilities	2.39 (1.70)	2.77 (1.36)	3.15 (1.18)	3.27 (.97)	1.92 (.17)	20.20 (.00)**	3.88 (.05)
2. Supervised Research Project							
a. Research project with your faculty mentor	3.07 (1.07)	3.15 (1.01)	3.27 (.88)	3.25 (.94)	.03 (.87)	2.48 (.12)	3.88 (.05)
b. Regular meetings with your faculty mentor	2.91 (1.09)	3.15 (.99)	3.15 (.99)	3.28 (.93)	2.19 (.14)	2.23 (.07)	3.83 (.25)
c. Scheduled meetings with SROP advisors/staff	2.27 (1.49)	2.79 (1.25)	3.10 (.97)	3.28 (.90)	5.03 (.03)	30.02 (.00)**	1.25 (.08)
d. Scheduled meetings with SROP peer mentors	1.93 (1.66)	2.17 (1.59)	2.81 (1.34)	3.00 (1.31)	1.22 (.27)	28.63 (.00)**	.56 (.46)
e. Sessions or presentations on research project writing	2.11 (1.55)	2.52 (1.47)	3.07 (1.07)	3.14 (1.00)	1.60 (.20)	34.82 (.00)**	5.08 (.03)
3. Graduate Studies Planning							
a. GRE exam preparation course	1.31 (1.46)	1.35 (1.51)	1.82 (1.56)	2.50 (1.47)	4.96 (.03)	18.79 (.00)**	.03 (.87)
b. Sessions on applying to graduate school	1.93 (1.59)	2.46 (1.49)	2.98 (1.18)	2.87 (1.29)	.82 (.37)	30.91 (.00)**	5.62 (.02)
c. Sessions on funding graduate studies	1.82 (1.60)	2.17 (1.62)	2.74 (1.30)	2.95 (1.19)	2.40 (.12)	34.40 (.00)*	.71 (.40)
d. Sessions on life as a graduate student	2.01 (1.61)	2.46 (1.62)	3.02 (1.19)	3.16 (1.12)	2.40 (.12)	19.70 (.00)*	1.51 (.22)
e. Opportunities for oral & written research project presentations	2.66 (1.42)	2.83 (1.34)	3.27 (.99)	3.35 (.99)	.64 (.43)	4.43 (.04)	2.18 (.14)

(continued)

Table 4.1 (continued)

Formal Organizational Support Items	Non-Underrepresented Groups (White/Other/Asian/ Hawaiian Pacific Islander) Female (N=90) Mean (*SD*)	Non-Underrepresented Groups (White/Other/Asian/ Hawaiian Pacific Islander) Male (N=47) Mean (*SD*)	Traditionally Underrepresented Minorities (Black, Hispanic/Latino(a)/ Alaskan/American Indian) Female (N=126) Mean (*SD*)	Traditionally Underrepresented Minorities (Black, Hispanic/Latino(a)/ Alaskan/American Indian) Male (N=60) Mean (SD)	Main Effect Gender *F*(Sig.)	Main Effect Race/ Ethnicity *F*(Sig.)	Interaction Effect Gender X Ethnicity *F*(Sig.)
4. Faculty Research Career Development							
a. Opportunity to observe faculty as role models	2.70 (1.57)	3.19 (1.04)	3.16 (1.06)	3.17 (.99)	1.32 (.11)	5.23 (.02)	5.45 (.82)
b. Opportunities to interact w/ graduate students	2.76 (1.38)	2.88 (1.16)	3.04 (1.14)	3.36 (.86)	2.76 (.10)	7.30 (0.01)*	.41 (.52)
c. Presentations on how to talk about my research	2.05 (1.42)	2.49 (1.44)	3.05 (1.13)	3.15 (1.13)	1.95 (.16)	34.51 (.00)**	1.75 (.19)
5. Strategic Networking Opportunities							
a. Formal opportunity for personal development	2.68 (1.63)	2.94 (1.23)	3.16 (1.06)	3.33 (.92)	2.09 (.15)	11.27 (.00)**	2.89 (.09)
b. Formal opportunity for social networking	2.46 (1.47)	2.94 (1.23)	3.12 (1.07)	3.24 (1.03)	3.44 (0.07)	15.27 (.00)**	6.72 (.01)*
6. Overal Program Satisfaction							
a. Overall, SROP experience last summer?	3.60 (.59)	3.71 (.54)	3.78 (.43)	3.79 (.54)	.67 (.42)	6.22 (.01)*	3.57 (.06)
b. Encourage/discourage others to apply?	2.62 (.94)	2.54 (.94)	2.36 (.72)	2.21 (.54)	1.44 (.23)	9.08 (.00)*	.79 (.38)

Note: The Bonferonni adjustment procedure was used to control for Type I error due to multiple comparisons, therefore the critical value was set at $p \leq .01$ for significance testing.
*$p \leq .01$, **$p \leq .001$.
Response scale for all items: 1= *Extremely Dissatisfied*, 2= *Somewhat Dissatisfied*, 3= *Somewhat Satisfied*, and 4= *Extremely Satisfied.*

results approached significance. Males tended to have higher scores on each of those items than females. In fact, males had higher mean scores on all but two items regardless of ethnicity. Despite these systematic trends in the data, however, the differences were not large enough to reach statistical significance at the .01 level.

In contrast to gender, there were several statistically significant ethnic differences on 15 out of 19 items. Traditionally underrepresented minority (URM) students (Black, Hispanic/Latino(a), Alaskan, American Indian) reported more positive experiences on all five categories of Formal Organizational Support, and higher levels of Overall Program Satisfaction on two indicators: "Overall, how satisfied were you with your experience as an SROP student this past summer?" and "Based on your experience as a SROP student this past summer, would you encourage or discourage another undergraduate to apply to the program?"

Cumulatively, these findings show that the formal organization of the SROP pipeline interventions had a more positive impact on URM students than on non-URM students. They further suggest that overall the interventions had a more positive impact for males than females. In addition to the main effects, there are a few interesting gender by ethnicity interaction effects. Females in the URM group rated higher on the "sessions on applying to graduate school" item than all other groups, although they had the lowest rating on the item that assessed "formal opportunity for social networking."

1b: CIC-SROP and OSROP Comparisons Strong Formal Organizational Support Items

Consistent with the definition of strong organizational support, I hypothesized that students who participated in the CIC-SROP (which has a greater number of program components) would be more satisfied with their program than students who participate in OSROPs. Research Question 1b addresses this component, as summarized in Table 4.2.

Table 4.2: T-Test Comparisons of CIC-SROP and OSROP Participants on Formal Organizational Support and Overall Program Satisfaction Items

	CIC-SROP		*OSROP*			
Formal Organizational Support Items	Mean	sd	Mean	sd	*t*	sig
1. Financial Aid						
a. Financial support including your SROP stipend and travel expenses	3.63	.65	3.23	.90	3.13	**
b. Campus resources including your housing and facilities	3.37	.86	2.98	1.34	2.03	**
2. Supervised Research Project						
a. Research project with your faculty mentor	3.35	.81	3.23	.99	.46	ns
b. Regular meetings with your faculty mentor	3.21	.98	3.09	1.03	.35	ns
c. Scheduled meetings with SROP advisors/staff	3.13	.92	2.87	1.30	1.35	ns
d. Scheduled meetings with SROP peer mentors	2.70	1.44	2.67	1.48	-.06	ns
e. Sessions or presentations on research project writing	3.13	.92	2.78	1.40	1.64	+
3. Graduate Studies Planning						
a. GRE exam preparation course	2.15	1.42	1.33	1.67	4.06	**
b. Sessions on applying to graduate school	3.00	1.08	2.66	1.39	1.58	ns
c. Sessions on funding graduate studies	3.00	1.03	2.16	1.65	4.78	**
d. Sessions on life as a graduate student	3.14	.96	2.77	1.47	2.19	**
e. Opportunities for oral & written research project presentations	1.24	.87	1.11	1.07	.87	ns
4. Faculty Research Career Development						
a. Opportunity to observe faculty as role models	3.18	.98	2.97	1.31	.87	ns
b. Opportunities to interact w/ graduate students	3.24	.91	2.94	1.41	1.48	ns
c. Presentations on how to talk about my research	3.12	1.06	2.64	1.47	2.56	*
d. Formal opportunity for personal development	3.30	.88	3.05	1.29	1.97	ns
e. Formal opportunity for social networking	3.21	.96	3.05	1.27	1.92	ns
5. OVERALL PROGRAM SATISFACTION						
a. Overall, SROP experience last summer?	3.85	,40	3.64	.64	2.36	**
b. Encourage/discourage others to apply?	3.93	.26	3.81	.43	2.70	*

Note: Bonferonni adjustment used to control Type I error for multiple *comparisons*, therefore $p \leq .01$ used for significance testing.
+ $p \leq .05$; *$p \leq .01$, **$p \leq .001$.
Response scale for all items: 1= *Extremely Dissatisfied*, 2= *Somewhat Dissatisfie*d, 3= *Somewhat Satisfied*, and 4= *Extremely Satisfied.*

A series of independent samples *t*-tests were conducted to compare CIC-SROP and OSROP participant responses on the items related to Formal Organizational Support. The data showed a statistically significant difference between the two groups on both items assigned to the Financial Aid Subscale, with CIC-SROP participants giving more positive ratings on both items. Although there were no statistically significant differences between the two groups on any of the items assigned to the Supervised Research Project subscale, differences did appear on three of the items in the Graduate Studies Planning subscale. The CIC-SROP participants scored higher than the OSROP participants on the items concerning GRE exam preparation course, sessions on funding graduate studies, and sessions on life as a graduate student. There also was one statistically significant difference on the Research Socialization subscale, where the CIC-SROP particpants scored higher on the item labeled "presentations on how to talk about my research," and on both items related to overall satisfation. These results suggest that CIC-SROP participants viewed formal organizational support elements more favorably than did OSROP participants.

1c: Strong Informal Organizational Support Items: Multiple Sources and Functions

The next step was to evaluate how much underrepresented students benefited from the presence of three major program sources, faculty mentors, staff, and peers, in terms of three critical functions – aid *(*material/technical), advice (guidance/information), and affirmation (socio-emotional/socialization). Thirty items were used to tap levels of informal organizational support on these functions, and repeated measures ANOVAs were run to assess differences across the program sources. The reported p-values represent values from the Greenhouse-Geisser statistics used to correct violations of the assumption of sphericity.

A careful review of the data in Table 4.3 reveals statistically significant differences in perceptions of informal organizational support from program faculty mentors, staff, and peers.

Table 4.3: ANOVA Comparisons of Three Sources of Informal Organizational Support on Multiple Functions

Multiple Functions	Three Major Program Sources: Faculty (N=332) Mean	Staff (N=334) Mean	Peers (N=332) Mean	*F*(Sig.)
1. Aid (Material/ Technical)				
a. Give me a ride if I needed one	3.91	4.06	4.38	58.81**
b. Look after my belongings for awhile	3.74	3.84	4.30	43.78**
c. Loan me a car if I needed one	2.51	2.69	3.48	88.04**
d. Help me out with some necessary purchase	2.66	2.91	3.59	68.74**
e. Loan me money for an indefinite period	2.13	2.37	3.01	74.24**
f. Buy me clothes if I was short of money	2.23	2.57	3.10	70.36**
g. Loan me tools, equipment, or appliances when I needed them	3.45	3.51	3.99	39.96**
h. Bring me little presents of things I needed	2.62	2.82	3.56	102.56**
i. Loan me money and want to "forget about it"	2.16	2.34	2.94	58.99**
j. Offer me a place to stay for awhile	2.51	2.84	3.78	161.05**
k. Loan me a fairly large sum of money (say equivalent to a month's rent)	1.96	2.16	2.57	35.62**
2. Advice (Guidance/ Information)				
a. Suggest how I could find out more about a situation	4.21	4.26	4.38	5.83*
b. Give me advice about what to do	4.28	4.30	4.44	6.78**
c. Help me figure out what I want to do	4.27	4.23	4.41	8.82**
d. Tell me about available choices and options	4.21	4.20	4.30	2.25
e. Tell me what to do	3.59	3.64	3.82	7.93**
f. Help me decide what to do	4.07	4.07	4.25	8.19**
3. Affirmation (Socio-Emotional Encouragement/ Socialization)				
a. Visit or come around me more	3.51	3.67	4.24	57.81**
b. Comfort me if I was upset	3.63	3.96	4.33	58.87**
c. Have lunch or dinner with me	3.94	3.97	4.46	44.81**
d. Joke around or suggest doing something to cheer me up	3.69	3.96	4.40	58.46**
e. Go to a movie, concert, or other social event with me	2.78	3.43	4.37	226.29**
f. Listen if I needed to talk about my feelings	3.61	4.02	4.40	69.44**
g. Have a good time with me	3.45	3.82	4.44	96.74**
h. Chat with me	4.19	4.27	4.53	22.17**
i. Show me that they understand how I was feeling	3.87	4.11	4.42	42.36**
j. Call me just to see how I was doing	2.87	3.40	4.20	160.23**
k. Be sympathetic if I was upset	3.76	3.97	4.38	66.67**
l. Show affection for me	3.02	3.42	4.21	144.07**
m. Show me how to do something I didn't know how to do	4.24	4.18	4.37	6.54*

Note: 1= Definitely No, 2= Probably No, 3= Maybe, 4= Probably Yes, and 5= Definitely Yes.
+ $p \leq .05$; *$p \leq .01$, **$p \leq .001$.

On 29 of the 30 items, UR students in SROP interventions consistently reported that peers were the most reliable source of aid, advice, and affirmation, followed by staff and then faculty. The one exception was item "d" on the advice function, where SROP participants reported that all three groups were about equally likely to "tell me about available choices and options."

1d: Factor Analysis of Formal Organizational Support Items: Scale and Multiple Subscales

In this measurement development section, I shifted from a focus on specific items to a focus on exploratory factor analysis in order to develop more reliable scales and subscales to measure organizational support. The exploratory factor analysis (EFA) procedure provides an empirical basis from which to better clarify this support as multidimensional constructs. Following existing strengths-based literature, EFA revealed the degree to which theory-driven (observed) factors emerged as the empirically-derived latent (hidden) constructs among the support measures. A series of factor analyses is presented in Tables 4.4 - 4.7. These analyses the construct validity of composite scales for both strong formal and informal organizational support. The results further clarify the multiple dimensions that emerged among the support measures and provide a deeper understanding of SROP participants' perceptions of support.

First, I will examine the Formal Organizational Support (FOS) items which were developed for this study. They have face validity in the sense that they are consistent with the formal CIC-SROP descriptions of major program components, and because campus-level SROP coordinators reviewed item contents for consistency with major program components. Because FOS is a new measure, empirically establishing the construct validity of the underlying factors and exploring whether the five expected components of program support would emerge are paramount.

To determine if the five hypothesized formal organizational support factors emerge empirically, exploratory factor analysis was conducted utilizing Principal Axis Factoring (PAF)

with a varimax rotation in order to maximize the variance among the factors (Mertler & Vannatta, 2005). Results from the Bartlett Test for the formal organizational support scale were $\chi^2 = 2485.75$ ($df = 153$, $p = .000$) and the Kaiser-Meyer-Olkin (KMO) was .92. Data from both tests indicated that the degree of intercorrelations among the items for formal organizational support was suitable for subjecting the data to EFA (Ary et al., 1996).

Table 4.4 presents a summary of the results from the factor analysis of the FOS items. Results did not yield the hypothesized five-factor structure; instead a three-factor solution was obtained. This three-factor model explained 54.83% of the shared variance in the items. The nine items loading on Factor 1 related to Graduate Studies Planning, hence this factor was named "Formal Graduate Planning." Factor 1 accounted for 25.88% of the variance in the data and the eigenvalue was 4.66. The five items loaded on Factor 2 were grouped under resources associated with socialization activities related to research, labeled "Formal Research Socialization." Factor 2 accounted for 19.43% of the variance in the items and the eigenvalue was 3.50. Lastly, three items describing resources linked to faculty mentor support loaded on Factor 3, named "Formal Mentor Support." It accounted for 11.16% of the variance in the items and the eigenvalue was 2.10.

Although three FOS factors were generated using factor analysis, four subscales were used in subsequent analyses. Based on theoretical considerations and the factor analysis results, Factor 1 was split into two subscales, "Formal Financial Resources" and "Formal Graduate

Table 4.4: Exploratory Factor Analysis for the Formal Organizational Support Scale

Formal Organizational Support Items	Factor 1: Formal Graduate Planning	Factor 2: Formal Research Socialization	Factor 3: Formal Research Mentor Support
1. Formal Graduate Planning			
a. Sessions on life as a graduate student	**.88**	.25	.17
b. Sessions on funding graduate studies	**.83**	.244	.18
c. Sessions on applying to graduate school	**.81**	.28	.14
d. Presentations on how to talk about my research	**.57**	.53	.22
e. Sessions or presentations on research project writing	**.55**	.55	.13
f. Opportunities for oral & written research project presentations	**.52**	.49	.22
g. GRE exam preparation course	**.49**	.22	.00
2. Formal Research Socialization			
a. Formal opportunity for personal development	.37	**.70**	.13
b. Formal opportunity for social networking	.45	**.67**	.15
c. Scheduled meetings with SROP advisors/staff	.37	**.58**	.23
d. Scheduled meetings with SROP peer mentors	.41	**.43**	.18
e. Opportunities to interact w/ graduate students	.36	**.37**	.36
3. Formal Mentor Support			
a. Regular meetings with your faculty mentor	.06	.16	**.84**
b. Research project with your faculty mentor	.18	.17	**.76**
c. Opportunity to observe faculty as role models	.26	.43	**.50**
4. Formal Financial Resources			
a. Financial support including your SROP stipend and travel expenses	**.45**	.42	.22
b. Campus resources including your housing and facilities	**.54**	.34	.24
VAF	25.88	19.43	11.16
Eigenvalue	4.66	3.50	2.10
Total Variance			**54.83%**

Planning." The two items addressing financial aid were grouped separately because they are not conceptually related to the other items loading on Factor 1. Therefore, the overall Formal Organizational Support -scale consists of the following four subscales: Formal Mentor Support, Formal Financial Resources, Formal Graduate Planning, and Formal Research Socialization.

To summarize, the factor analysis results clearly show that SROP strong formal organizational support can be measured with a reliable scale that includes empirically distinguishable subscales representing multiple components. However, only four rather than the hypothesized five factors emerged empirically. These formal intervention support components were initially conceptualized from the program theory and empirically validated by factor analysis. Although loosely linked empirically, Formal Financial Resources will be analyzed separately from Formal Graduate Planning because of their distinct conceptual and policy relevance.

1d: Factor Analysis of Informal Organizational Support Items: Scales and Subscales

To further address ***Research Aim 1d***, factor analysis results are presented next for three Informal Organizational Support (IOS) scales, which were adapted for this study to systematically assess informal support from the three major program sources – faculty mentor, staff, and peers. Consistent with the broader informal support literature, each of the three IOS scales consists of 30 items that tap three critical factors – aid, advice, and affirmation. The focus in this study on the three major sources of informal organizational support within pipeline interventions goes beyond existing research, which largely has been restricted to exploring informal support from family and friends.

Table 4.5 presents a summary of the results for the EFA on the informal faculty mentor organizational resources. Results from the Bartlett Test for the formal resources were χ^2 =

8585.94 (*df* = 435, *p* = .000). The Kaiser-Meyer-Olkin was .94. These results indicated that the degree of correlations among the Faculty Mentor - IOS Scale items was adequate for performing exploratory factor analysis. As expected, the results showed that a three-factor solution accounted for 63.03% of the variance, and that the empirical factors align with the hypothesized factors of aid, advice, and affirmation.

Consistent with the broader informal social support literature, Factor 1 consisted of items relating to informal faculty advice. This factor retained the name Informal Faculty Advice. Factor 1 accounted for 25.90% of the variance, and the eigenvalue was 7.77. Factor 2 consisted of items relating to informal faculty aid. This factor retained the name Informal Faculty Aid. It accounted for 23.67% of the variance, and the eigenvalue was 2.09. Factor 3 consisted of items relating to informal faculty affirmation. This factor retained the name Informal Faculty Affirmation. Factor 3 accounted for 13.86% of the variance, and the eigenvalue was 4.16. Therefore, to summarize, the hypothesized three factors were obtained from the factor analysis for the Informal Faculty Support scale.

Table 4.6 presents a summary of results from the factor analysis on the informal staff organizational resources. Results from the Bartlett Test were χ^2 =10326.41 (*df* = 435, *p* = .000) and the KMO was .96, indicating that the degree of correlations among variables was adequate for performing EFA. Again, as expected, the results showed that a three-factor solution accounted for 70.16% of the variance and that the emerged factors aligned with the hypothesized factors. Factor 1 consisted of items relating to informal staff advice, accounting for 29.30% of the variance, and the eigenvalue was 8.79. Factor 2 related to informal faculty aid. It accounted for 23.41% of the variance, and the eigenvalue was 7.07. Factor 3 concerned informal staff affirmation and accounted for 17.45% of the variance, with an eigenvalue of 5.24.

Table 4.5: Exploratory Factor Analysis Results for "Faculty Mentor" - Informal Organizational Support Scale

Informal Program Faculty Mentor Items	Factor 1: Informal Faculty Advice	Factor 2: Informal Faculty Aid	Factor 3: Informal Faculty Affirmation
1. Informal Faculty Advice			
a. Help me figure out what I want to do	**.83**	.19	.20
b. Tell me about available choices and options	**.83**	.10	.16
c. Help me decide what to do	**.81**	.20	.17
d. Give me advice about what to do	**.80**	.13	.26
e. Suggest how I could find out more about a situation	**.76**	.12	.23
f. Show me how to do something I didn't know how to do	**.75**	.11	.21
2. Informal Faculty Aid			
a. Loan me money and want to "forget about it"	.13	**.88**	.11
b. Loan me a fairly large sum of money (say equivalent to a month's rent)	.09	**.87**	.11
c. Loan me money for an indefinite period	.11	**.85**	.22
d. Buy me clothes if I was short of money	.16	**.82**	.17
e. Offer me a place to stay for awhile	.25	**.71**	.25
f. Help me out with some necessary purchase	.23	**.67**	.36
g. Bring me little presents of things I needed	.26	**.64**	.32
h. Loan me a car if I needed one	.15	**.61**	.43
i. Call me just to see how I was doing	.37	**.55**	.40
j. Show affection for me	.41	**.54**	.27
k. Loan me tools, equipment, or appliances when I needed them	.37	**.46**	.36

(continued)

Table 4.5 (continued)

Informal Program Faculty Mentor Items	Factor 1: Informal Faculty Advice	Factor 2: Informal Faculty Aid	Factor 3: Informal Faculty Affirmation
3. Informal Faculty Affirmation			
a. Have lunch or dinner with me	.39	.27	**.61**
b. Give me a ride if I needed one	.34	.30	**.60**
c. Joke around or suggest doing something to cheer me up	.46	.32	**.57**
d. Go to a movie, concert, or other social event with me	.26	.53	**.56**
e. Look after my belongings for awhile	.27	.27	**.54**
f. Have a good time with me	.43	.44	**.54**
g. Comfort me if I was upset	.51	.27	**.51**
h. Visit or come around me more	.39	.41	**.42**
VAF	25.90	23.67	13.86
Eigenvalue	7.77	2.09	4.16
Total Variance			**63.03%**

Table 4.6: Exploratory Factor Analysis Results for "Program Staff" – Informal Organizational Support Scale

	Factor 1: Informal Staff Advice	Factor 2: Informal Staff Aid	Factor 3: Informal Staff Affirmation
1. Informal Program Staff Advice			
a. Tell me about available choices and options	**.85**	.14	.21
b. Help me decide what to	**.84**	.24	.13
c. Give me advice about what to do	**.82**	.07	.36
d. Help me figure out what I want to do	**.81**	.11	.35
e. Show me how to do something I didn't know how to do	**.78**	.13	.20
f. Suggest how I could find out more about a situation	**.76**	.07	.40
g. Chat with me	**.74**	.09	.43
h. Show me that they understand how I was feeling	**.71**	.11	.49
i. Listen if I needed to talk about my feelings	**.70**	.21	.47
j. Be sympathetic if I was upset	**.68**	.25	.30
k. Tell me what to do	**.57**	.38	.16
l. Show affection for me	**.51**	.49	.26
2. Informal Program Staff Aid			
a. Loan me money and want to "forget about it"	.06	**.91**	.07
b. Loan me a fairly large sum of money (say equivalent to a month's rent)	.00	**.89**	.08
c. Loan me money for an indefinite period	.06	**.88**	.08
d. Buy me clothes if I was short of money	.17	**.82**	.16
e. Offer me a place to stay for awhile	.24	**.77**	.25
f. Bring me little presents of things I needed	.27	**.76**	.17
g. Help me out with some necessary purchase	.22	**.76**	.27
h. Loan me a car if I needed one	.08	**.64**	.33
i. Loan me tools, equipment, or appliances when I needed them	.46	**.53**	.34
j. Call me just to see how I was doing	.43	**.51**	.43

(continued)

Table 4.6 (continued)

	Factor 1: Informal Staff Advice	Factor 2: Informal Staff Aid	Factor 3: Informal Staff Affirmation
3. Informal Program Staff Affirmation			
a. Have lunch or dinner with me	.43	.24	**.73**
b. Give me a ride if I needed one	.45	.20	**.72**
c. Look after my belongings for awhile	.37	.28	**.64**
d. Comfort me if I was upset	.56	.17	**.63**
e. Go to a movie, concert, or other social event with me	.32	.43	**.63**
f. Joke around or suggest doing something to cheer me up	.56	.22	**.61**
g. Visit or come around me more	.38	.32	**.61**
h. Have a good time with me	.52	.35	**.54**
VAF	29.30	23.41	17.45
Eigenvalue	8.69	7.07	5.24
Total Variance			**70.16%**

Table 4.7 presents a summary of the EFA results on informal peer organizational support. Results from the Bartlett Test for the informal peer items were χ^2 =14734.20 (df = 435, p = .000). The Kaiser-Meyer-Olkin was .97. These results indicated that the degree of intercorrelations among variables was adequate for performing EFA. The EFA resulted in a two-factor solution that generally aligned with the hypothesized factors, and accounted for 77.12% of the variance. Items were loaded on Factor 1, from the hypothesized peer advice and affirmation subscales, named Informal Peer Advice and Affirmation. Factor 1 accounted for 53.56% of the variance, and the eigenvalue was 16.07. Factor 2, Informal Peer Aid, accounted for 23.56% of the variance, and the eigenvalue was 7.07.

In summary, the three hypothesized factors – aid, advice, and affirmation – were obtained only from the factor analyses on the Informal Faculty Support and the Informal Staff Support scales. In contrast, for Informal Peer Support, only two factors – Aid, and Advice/Affirmation – instead of the hypothesized three emerged from the factor analysis.

1d: Reliability Coefficients for Organizational Support Scales and Subscales

To complement the factor analysis results, a reliability analysis also was conducted to address Research Question 1d. Cronbach's Alpha coefficients for the formal and informal organizational support scales are summarized in this section. They further support the reliability of the derived scales and subscales. The support scales were created by summing the items loading on each factor and then dividing by the total number of items on each scale. The reliability or internal consistency of these scales and subscales was assessed by computing the Cronbach's Alpha. The alpha coefficients were computed for the overall Formal and Informal Organizational Support scales, and for the subscales for each.

Table 4.7: Exploratory Factor Analysis Results for "Program Peers" – Informal Organizational Support Scale

	Factor Loadings	
	Factor 1: Informal Peer Advice and Affirmation	Factor 2: Informal Peer Aid
1. Informal Program Peer Advice and Affirmation		
a. Chat with me	**.93**	.12
b. Have a good time with me	**.93**	.21
c. Give me advice about what to do	**.92**	.21
d. Listen if I needed to talk about my feelings	**.92**	.23
e. Have lunch or dinner with me	**.91**	.20
f. Help me figure out what I want to do	**.91**	.26
g. Show me that they understand how I was feeling	**.91**	.23
h. Joke around or suggest doing something to cheer me up	**.90**	.25
i. Suggest how I could find out more about a situation	**.89**	.23
j. Comfort me if I was upset	**.88**	.30
k. Go to a movie, concert, or other social event with me	**.88**	.26
l. Be sympathetic if I was upset	**.87**	.26
m. Give me a ride if I needed one	**.85**	.28
n. Show me how to do something I didn't know how to do	**.84**	.25
o. Look after my belongings for awhile	**.80**	.34
p. Tell me about available choices and options	**.78**	.31
q. Visit or come around me more	**.77**	.35
r. Show affection for me	**.76**	.42
s. Help me decide what to do	**.74**	.38
t. Call me just to see how I was doing	**.69**	.43
u. Loan me tools, equipment, or appliances when needed	**.61**	.57
v. Tell me what to do	**.46**	.45
2. Informal Program Peer Aid		
a. Loan me money for an indefinite period	.14	**.87**
b. Buy me clothes if I was short of money	.25	**.87**
c. Loan me money and want to "forget about it"	.12	**.87**
d. Loan me a fairly large sum of money (say equivalent to a month's rent)	.01	**.84**
e. Help me out with some necessary purchase	.40	**.74**
f. Bring me little presents of things I needed	.42	**.72**
g. Loan me a car if I needed one	.32	**.67**
h. Offer me a place to stay for awhile	.52	**.66**
VAF	53.56	23.56
Eigenvalue	16.07	7.07
Total Variance		**77.10%**

The coefficient alphas and means for the FOS Scale Overall and subscales are presented in Table 4.8. The alpha coefficient for the FOS Scale Overall was found to be highly reliable (α = 0.91). The FOS Scale Overall consisted of four subscales: Formal Financial Resources (FFR), Formal Graduate Planning (FGP), Formal Research Socialization (FRS), and Formal Mentor Support (FMS). Related alpha coefficients indicated that the various subscales were also highly reliable – FFR consisted of two items (α = 0.74), FGP seven items (α = 0.91), FRS five items (α = 0.83), and FMS three items (α = 0.78). Overall, UR students scored the highest levels of formal organizational support on FGP (M = 3.87) followed by FMS (M = 3.10), FRS (M = 2.87), and FFR (M = 2.54).

The coefficient alphas and means for the IOS scale and its subscales are presented in Table 4.9. The IOS scale consisted of three scales, each composed of 30 items. The three scales were Informal Mentor Support (IMS), Informal Staff Support (ISS), and Informal Peer Support (IPS). Each scale was further subdivided into three subscales (aid, advice, and affirmation). The means and coefficient alphas for the scales and subscales are presented in Table 4.9. The alpha coefficient for the IOS scale overall was found to be highly reliable (α = 0.91).

The overall alpha for the IMS scale was α = 0.97. The obtained alphas for its three subscales ranged from 0.84 to 0.94, with an average of 0.90. The similar figures for the ISS scale were α = 0.97, ranging from 0.93 to α = 0.96, averaging 0.94, and α = 0.98, α = 0.95 to α = 0.98, and α = 0.97 respectively for the IPS.

A review of the means revealed that students gave higher ratings on the Advice subscale for program staff and faculty mentor but a lower rating for peers. The mean rating was highest for the ISS Advice subscale (M = 4.12) compared to the IMS (M = 4.10) and IPS (M = 3.08) subscales. The next highest ratings were on the Affirmation subscale for the ISS (M = 3.87),

Table 4.8: Means and Coefficient Alphas for Formal Organizational Support Scale, Subscales, and Overall Program Satisfaction Index

Overall Scale and Subscales	Mean	α
Formal Organization Support (FOS) Scale Overall	3.18	0.91
1. Formal Financial Resources (FFR) Subscale	2.54	0.74
a. Financial support including your SROP stipend and travel		
b. Campus resources including your housing and facilities		
2. Formal Graduate Planning (FGP) Subscale	3.87	0.91
a. Sessions on life as a graduate student		
b. Sessions on funding graduate studies		
c. Sessions on applying to graduate school		
d. Presentations on how to talk about my research		
e. Sessions or presentations on research project writing		
f. Opportunities for oral & written research project presentations		
g. GRE exam preparation course		
3. Formal Research Socialization (FRS) Subscale	2.87	0.83
a. Formal opportunity for personal development		
b. Formal opportunity for social networking		
c. Scheduled meetings with SROP advisors/staff		
d. Scheduled meetings with SROP peer mentors		
e. Opportunities to interact with graduate students		
4. Formal Mentor Support (FMS) Subscale	3.10	0.78
a. Regular meetings with your faculty		
b. Research project with your faculty mentor		
c. Opportunity to observe faculty as role models		

Note: Response scale for all items: 1= *Extremely Dissatisfied*, 2= *Somewhat Dissatisfie*d, 3= *Somewhat Satisfied*, and 4= *Extremely Satisfied.*

Table 4.9: Means and Alphas for Subscales of Three Informal Organizational Support Scales

Mentor Subscales	Mean	α
1. Informal Mentor Support (IMS)	3.33	.97
a. Aid (11 Items)	2.99	.84
b. Advice (11 Items)	4.10	.91
c. Affirmation (8 Items)	3.57	.94
2. Informal Staff Support (ISS)	3.58	.97
a. Aid (10 Items)	2.92	.94
b. Advice (12 Items)	4.12	.93
c. Affirmation (8 Items)	3.87	.96
3. Informal Peer Support (IPS)	4.04	.98
a. Advice/Affirmation (22 Items)	3.08	.98
b. Aid (8 Items)	4.30	.95

Note: Response scale for all items: 1= *Definitely No*, 2= *Probably No*, 3= *Maybe*, 4= *Probably Yes*, and 5= *Definitely Yes*.

compared to $M = 3.57$ for the IMS and $M = 3.08$ for the IPS. Students also gave higher ratings on the Aid subscale for IPS ($M = 4.30$) compared to those for the IMS Aid subscale ($M = 2.99$) and the ISS Aid subscale ($M = 2.92$).

Next, I address the two subsidiary questions of measurement development question 1d, in order to further establish the validity of the formal and informal organizational support scales: Can *formal* organizational support scales and subscales help to better clarify *meaningful difference*s between strong CIC-SROP and OSROP interventions?, Is there a significant relationship between strong *formal and informal* organizational support *scales*? A one-way ANOVA was conducted to compare CIC-SROP and OSROP participant responses on the Formal Organizational Support scale and its subscales. These results are summarized in Table 4.10. As expected, there are statistically significant differences that clearly support CIC-SROP as a strong

pipeline intervention providing high levels of formal organizational support. The CIC-SROP participants had significantly higher scores compared to the OSROP participants on the overall formal organizational support scale, with three of the four subscales – Formal Financial Resources, Formal Graduate Planning and Formal Research Socialization. In contrast, there was no statistically significant difference between CIC-SROP and OSROP participants on the Formal Mentor Support subscale. This suggests that the types of formal support provided by faculty-mentors are equally strong within CIC-SROP and other faculty mentored summer research experiences for undergraduates. However, CIC-SROP participants consistently perceived higher levels of formal organizational support than did OSROP participants. Hence, it appears that CIC-SROP students benefited from the strong intervention design that provided multiple program components and social capital.

To further support the discriminant and predictive validity of the organizational support scales, I calculated the inter-correlations among the FOS scale, the IOS scale, and the two outcome variables under study – overall program satisfaction and STEM research career plans.

Table 4.10: CIC-SROP and OSROP Differences on Formal Organizational Support Scales and Subscales

Scale	CIC-SROP (N=207)	OSROP (N=64)	*Sig*
Formal Organization Support Scale (FOS total)	53.16	47.39	**
FOS subscale			
Formal Graduate Planning	20.87	17.48	**
Formal Financial Resources	6.99	6.20	**
Formal Research Socialization	15.58	14.41	+
Formal Mentor Project Support	9.73	9.31	.23

Note: + $p \leq .05$; *$p \leq .01$, **$p \leq .001$.

Table 4.11 displays the consistent relationships among FOS and the three IOS scales – Faculty Mentor Support (*r*=.29**), Staff Support (*r*=.43**), and Peer Support (*r*=.37**). As expected, there were statistically significant relationships among the three sources of Informal Organizational Support (*r*=.26** ranging to .67**). Table 4.11 also displays two distinct patterns in the relationships among the various organizational support indicators and the two outcome variables. First, Overall Program Satisfaction was strongly related to Formal Organizational Support (*r*=.51**) but only modestly related to the three sources of Informal Support (*r*=-.22** ranging to .32**). Second, STEM Research Career Plans was significantly linked to both Informal Faculty Support (*r*= .20**) and Overall Program Satisfaction (*r*= .19**).

To further support the discriminant and predictive validity of the organizational support scales, I calculated the inter-correlations among the FOS scale, the IOS scale, and the two

Table 4.11: Correlations between Outcome Variables, Formal and Informal Organizational Support

	Outcome Variables		Formal Organizational Support Variables	Informal Organizational Support Variables	
	Overall Program Satisfaction	STEM Career Plans	FOS - Formal Organizational Support Scale Total	Informal Faculty Support Subscale	Informal Staff Support Subscale
STEM Career Plans	.19**				
FOS - Formal Organizational Support Scale Total	.51**	.05			
IFS- Informal Faculty Support Subscale	.23**	.20**	.29**		
ISS - Informal Staff Support Subscale	.32**	.06	.43**	.42**	
IPS - Informal Peer Support Subscale	.22**	-.01	.37**	.26**	.67**

Note: + p ≤ .05; *p ≤ .01, **p ≤ .001.

outcome variables under study – overall program satisfaction and STEM research career plans.

Research Aim 2: Strengths-Based Predictive Relationships

In this section I explore in greater detail a set of strengths-based predictive relationships in order to further establish the validity of the formal items and informal organizational support scales described previously. More specifically, as stated by Research Aim 2, the research results provide an avenue to explore how strong formal and informal organizational support measures may help to explain overall program satisfaction and successful STEM outcomes among UR students in pipeline interventions. The presentation of these results is organized around three related research questions: (2a) In addition to objective pipeline intervention participation, do *formal and informal* organizational support factors further enhance program satisfaction and successful STEM outcomes? (2b) Are the effects of *formal and informal* organizational support on successful STEM outcomes stronger among pipeline intervention participants facing higher role stress? (2c) In addition to strong organizational support, do "adaptive strengths" among pipeline intervention participants help to buffer any deleterious effects of role stress on their successful STEM outcomes?

2a: Organizational Support Predictors and Successful Outcomes: Program Satisfaction and STEM Research Career Plans

The first research question was designed to better understand how objective pipeline intervention combined with formal and informal organizational support to explain successful STEM outcomes. Hierarchical multiple regressions were employed to examine the relationships among four sets of predictor variables (Program Intervention, Formal and Informal Organizational Support, STEM Major, and STEM Major Interactions) and two outcome

variables (Overall Program Satisfaction and STEM Research Career Plans). Results from separate regression analyses are presented below for each outcome variable.

Prediction of Overall Program Satisfaction

The Overall Program Satisfaction indicator was entered as the dependent variable in the first hierarchical regression analysis. Guided by the theory-driven specific aim, the predictor variables were entered in four separate steps: Step 1, program intervention; Step 2, formal and informal organizational support; Step 3, STEM major (as a control variable); and Step 4, STEM Major Interactions (STEM Major by Program Intervention, STEM Major by Formal Organizational Support, and STEM Major by Informal Organizational Support). Table 4.12 displays the results of these analyses.

Model 1 includes the indicator for intervention participation, where 1 = CIC-SROP and 0 = OSROP. This model accounts for 3% of the variance in Overall Program Satisfaction, which is statistically significant from zero ($p \leq .01$), suggesting that participation in a more strongly designed intervention explains some of the variance in students' satisfaction with their summer

Table 4.12: Hierarchical Regression of the Predictive Relationships between Intervention, Organizational Support, Controls, and Overall Program Satisfaction (n = 220)

	Overall Program Satisfaction Models			
Predictor Variables	Model 1: Program Intervention	Model 2: Organizational Support Subscales	Model 3: Control	Model 4: Interactions
Intervention				
Program Intervention	.24**	.12	.11	.26
Organizational Support Scales				
Formal Organizational Support (FOS Total)		.01***	.01***	.01***
Informal Organizational Support (IOS Total)		.00	.00	.00
Control				
STEM Major			.14*	.20*
STEM Major Interactions				
STEM Major X Program Intervention				-.16
STEM X FOS Total				--
STEM X IOS Total				--
Constant	3.54	2.71	2.61	2.49
F (for regression model)	6.87**	22.02***	17.90***	12.23***
Change in F	6.87**	28.73***	4.46*	.93
R^2	.03	.23	.25	.25
Change in R^2	.03	.20	.02	.01

Note: Unstandardized coefficients reported.
*p ≤ .05; **p ≤ .01; ***p ≤ .001.
Intervention Coded 1= CIC-SROP and 0 = OSROP. STEM Major Coded 1= STEM Major and 0 = Other Major.
-- Due to high levels of correlations between the variables, the interaction term was unable to be calculated in SPSS.
Overall Program Satisfaction Scale: 1= *Extremely Dissatisfied*, 2= *Somewhat Dissatisfied*, 3= *Somewhat Satisfied*, and 4= *Extremely Satisfied*.

research activity. On average, students in the CIC-SROP program were significantly more satisfied with their experience than were OSROP program participants.

Model 2 adds formal and informal organizational support indicators to the analysis. Here, only formal organizational support is related to Overall Program Satisfaction ($p \leq .001$). This model accounts for 23% of the variance in the outcome and is statistically significant ($p \leq .001$). The change in the variance accounted for from Model 1 to Model 2 also was statistically significant ($p \leq .01$). When the specific organizational supports that are formally implemented in research opportunity programs are taken into account, however, the indicator for program participation is no longer a statistically significant predictor of variance in the outcome. Taken together, these results suggest that regardless of whether students are participating in CIC-SROP or OSROP, formal organizational support is a significant predictor of their satisfaction.

Model 3 adds the indicator for students' STEM major to the analysis. It is a significant predictor of Overall Program Satisfaction; students majoring in STEM were more satisfied with their summer research experiences than their peers in other majors. This model accounts for 25% of the variance in satisfaction, but there was no significant change in the explained variance from Model 2 to Model 3. Interestingly, formal organizational support remains a significant predictor ($p \leq .001$) of Overall Program Satisfaction after accounting for STEM major.

Model 4 includes the three STEM major interaction effects of interest. It accounts for 25% of the variance and does not represent a substantial improvement in the amount of variance that is accounted for. This model suggests that STEM major does not moderate the relationship between program intervention and Overall Program Satisfaction, nor that between formal organizational support or informal organizational support and Overall Program Satisfaction. However, the conditional effect for STEM major remains significant from Model 3 to Model 4,

suggesting that across SROPs the relationship between STEM major and Overall Program Satisfaction is not significantly diminished or strengthened by any type of organizational support.

Prediction of STEM Research Career Plans

The hierarchical regression model predicting STEM Research Career Plans first includes the indicator for intervention participation, where 1 = CIC-SROP and 0 = OSROP. (see Table 4.13.) Model 1 accounts for only 1% of the variance here. This suggests that participation in either CIC-SROP or OSROP does not explain the variance in students' career plans when other covariates are not being controlled for.

Model 2 adds formal and informal organizational support indicators to the analysis. Neither type of support was found to be significantly related to students' plans to pursue STEM research careers. This model accounts for only 3% of the variance in career plans and was not statistically significant. The change in variance from Model 1 to Model 2 also was not statistically significant ($p \leq .01$). This indicates that the addition of the organizational support variables does not improve prediction of STEM Research Career Plans.

Model 3 adds the indicator for students' college major (STEM versus non-STEM) to the analysis. It accounts for 39% of the variance, suggesting that students majoring in STEM are significantly more certain to pursue STEM Research Career Plans, whereas program intervention and organizational supports are not significant contributors. The change in R-square was statistically significant, indicating that the unique contribution of STEM major explains a significant proportion of the variance in STEM Research Career Plans.

Model 4 includes the three STEM major interaction effects, accounting for 39% of the variance in the outcome. It does not represent a substantial improvement in the amount of

Table 4.13: Hierarchical Regression of the Predictive Relationships between Intervention, Organizational Support, Controls, and STEM Research Career Plans (n = 220)

	Models for STEM Research Career Plans			
Predictor Variables	Model 1: Program Intervention	Model 2: Organizational Support Subscales	Model 3: Control	Model 4: Interactions
Intervention				
Program Intervention	.36	.26	.14	.22
Organizational Support Scales				
Formal Organizational Support (FOS Total)		.01	.00	.00
Informal Organizational Support (IOS Total)		.00	.00	.00
Control				
STEM Major			1.85***	1.86***
STEM Major Interactions				
STEM Major X Program Intervention				-.21
STEM Major X FOS Total				--
STEM Major X IOS Total				--
Constant	2.71	1.82	.51	.45
F (for regression model)	1.96	2.32	34.58***	22.85***
Change in F	1.96	2.48	127.30***	.02
R^2	.01	.03	.39	.39
Change in R^2	.01	.02	.36	.00

Note: Unstandardized coefficients reported.
*p ≤ .05; **p ≤ .01; ***p ≤ .001.
Intervention Coded 1= CIC-SROP and 0 = OSROP.
STEM Major Coded 1= STEM Major and 0= Other Major.
-- Due to high levels of correlations between the variables, the interaction term was unable to be calculated in SPSS.
STEM Research Career Plans Scale: 1) *Completely certain I will not pursue a STEM research career*, 2) *Pretty certain I will not*, 3) *Some possibility I will*, 4) *Pretty certain will*, and 5) *Completely certain I will*.

variance accounted for over Model 3, which is not surprising given that the interactions are not statistically significant. In other words, STEM major does not moderate the relationships between program intervention and STEM Research Career Plans, or between formal and informal organizational support and STEM Research Career Plans. It does, however, remain a significant predictor of STEM Research Career Plans.

In summary, formal organizational support does enhance students' overall program satisfaction, whereas informal organizational support does not. Students majoring in STEM fields are more satisfied with their SROP in comparison to their non-STEM peers, regardless of the pipeline intervention in which they participated. They also are significantly more certain that they will pursue STEM research careers in the future. While formal organizational support is a significant predictor of overall program satisfaction even after accounting for STEM major and program intervention, it did not predict students' STEM research career plans. Interestingly, in both models, informal organizational support was not statistically significant, and STEM major did not moderate the relationships among program intervention, organizational supports, and successful STEM outcomes.

2b: Stress Buffering Role of Organizational Support

Research question 2b seeks to better understand the degree to which formal and informal organizational support and STEM major moderate the relationship between student role stress and successful STEM outcomes. To address this question, regression analyses were conducted on the relationships between a relevant set of predictors (Program Intervention, Formal and Informal Organizational Support, Student Role Stress, Student Role Stress Interactions, and STEM Major) and two outcome variables (Overall Program Satisfaction and STEM Research

Career Plans). Again, the results for Overall Program Satisfaction are presented first, followed by the results for the STEM Research Career Plans model (see Tables 4.14 and 4.15).

Prediction of Overall Program Satisfaction

As shown in Table 4.14, the Overall Program Satisfaction rating was entered as the dependent variable in the hierarchical regression analysis. Guided by Research Aim 3, the predictor variables were entered in five separate steps. In Step 1 the program intervention variable was entered. The formal and informal organizational support scale scores were entered in Step 2, then the student role stress variable in Step 3. In Step 4 the student role stress interactions (formal organizational support by student role stress, informal organizational support by student role stress, and program intervention by student role stress) were included. Lastly, in Step 5, the STEM major variable was entered as a control variable.

Model 1 in the hierarchical regression (Table 4.14) includes the indicator for participation, where 1 = CIC-SROP and 0 = OSROP. It accounts for 4% of the variance in Overall Program Satisfaction, which is statistically significant from zero ($p \leq .01$). This suggests that intervention participation helps to explain students' satisfaction with their summer research activity. On average, students in the CIC-SROP were significantly more satisfied with their experience than the OSROP participants. Model 2 adds formal and informal organizational support indicators to the analysis. Both are related to Overall Program Satisfaction (respectively, $p \leq .001$ and $p \leq .01$), accounting for 29% of the variance in the outcome ($p \leq .001$). The change in the variance from Model 1 to Model 2 also was statistically significant ($p \leq .01$). When the specific organizational supports that are formally or informally implemented in summer research opportunity programs are taken into account, the indicator for program participation is no longer a significant predictor of variance in the outcome. Taken together, these results suggest that

Table 4.14: Hierarchical Regression of the Predictive Relationships between Intervention, Organizational Support, Support by Student Role Stress Interactions, and Overall Program Satisfaction (n = 188)

Predictor Variables	Model 1: Program Intervention	Model 2: Organizational Support Scales	Model 3: Student Role Stress Subscale	Model 4: Interactions	Model 5: Control
Intervention					
Program Intervention	.41**	.24	.24	.34**	.34**
Organizational Support Scales					
Formal Organizational Support (FOS Total)		.02***	.02***	-.02	-.03
Informal Organizational Support Scale (IOS Total)		.00*	.00*	.00*	.00*
Student Role Stress Subscale					
Role Overload (RO)			-.00	-.07**	-.08**
Student Role Stress Interactions					
FOS Total X Role Overload (RO)				.00**	.00**
IOS Total X RO				--	--
Program Intervention X RO				--	--
Control					
STEM Major					.21*
Constant	7.25	5.64	5.69	7.42	7.57
F (for regression model)	7.96**	24.83***	18.53***	16.61***	14.78***
Change in F	7.96**	31.95***	.03	6.62**	4.20*
R^2	.04	.29	.29	.31	.33
Change in R^2	.04	.25	.00	.03	.02

Note: Unstandardized coefficients reported.
*p ≤ .05; **p ≤ .01; ***p ≤ .001.
Intervention Coded 1= CIC SROP and 0 = OSROP. STEM Major Coded 1= STEM Major and 0 = Other Major.
-- Due to high levels of correlations between the variables, the interaction term was unable to be calculated in SPSS.
Overall Program Satisfaction Scale: 1= Extremely Dissatisfied, 2= Somewhat Dissatisfied, 3= Somewhat Satisfied, and 4= Extremely Satisfied.

regardless of whether students participate in CIC-SROP or OSROP, organizational support is a significant predictor of Overall Program Satisfaction.

Model 3 adds the indicator for student role stress to the analysis, but it is not a significant predictor of Overall Program Satisfaction and accounts for only 29% of the variance. There was no significant change in the amount of variance explained from Model 2 to Model 3. Interestingly, formal and informal organizational support remain significant predictors ($p \leq .001$ and $p \leq .01$ respectively) of Overall Program Satisfaction after accounting for student role stress.

Model 4 includes the three student role stress interactions. It accounts for 31% of the variance and does not represent a substantial improvement in the amount of variance accounted for. This model suggests that as student role stress increases, Overall Program Satisfaction decreases when controlling for program intervention and organizational support. However, the interaction between informal organizational support and student role stress is significant and positive ($p \leq .01$). The relationship between formal organizational support and Overall Program Satisfaction is strengthened for SROP participants experiencing high role stress. Interestingly, program intervention was significant ($p \leq .01$) when student role stress was entered into the model controlling for organizational support and student role stress.

All of the effects found in Model 4 remained the same in Model 5. In addition, STEM major was a statistically significant predictor ($p \leq .05$) of Overall Program Satisfaction, with STEM students having higher ratings than their non-STEM peers. This model accounts for 33% of the variance, which is not a substantial improvement in the amount of variance explained. In summary, after controlling for other factors in the Overall Program Satisfaction model, students with a STEM major remain more satisfied with their program experience than non-STEM peers.

Prediction of STEM Research Career Plans

The hierarchical regression model predicting STEM Research Career Plans (shown in Table 4.15) first includes the indicator for intervention participation, where 1 = CIC-SROP and 0 = OSROP. Model 1 accounts for 1% of the variance in STEM Research Career Plans, which is not statistically significant from zero. This suggests that participation in either type of opportunity program does not explain the variance in students' STEM Research Career Plans when other covariates are not included in the model.

Model 2 adds formal and informal organizational support indicators to the analysis. Neither formal nor informal organizational support was found to be significantly related to students' plans to pursue STEM research careers. This model accounts for only 3% of the variance in the students' STEM Research Career Plans and is not statistically significant, nor is the change in variance from Model 1 ($p \leq .01$). This indicates that the variance explained by the unique contribution of the organizational support variables is not statistically significant; their inclusion does not improve prediction of STEM Research Career Plans.

Model 3 adds the indicator for student role stress to the analysis, accounting for 7% of the variance in STEM Research Career Plans. This suggests that students with role stress have a significantly greater level of certainty in their career plans, and program intervention and organizational supports are not significant contributors to their plans.

Model 4, which includes the three student role stress interactions, accounts for 10% of the variance in the outcome but does not represent a substantial improvement in the amount of variance accounted for over Model 3. This suggests that as students perceive higher levels of informal organizational support, their pursuit of STEM research careers becomes more uncertain. However, the interaction between informal organizational support and student role stress is

Table 4.15: Hierarchical Regression of the Predictive Relationships between Intervention, Organizational Support, Student Role Stress Interactions, and STEM Research Career Plans (n = 188)

	STEM Research Career Models				
Predictor Variables	Model 1: Program Intervention	Model 2: Organizational Support Scales	Model 3: Student Role Stress Subscale	Model 4: Interactions	Model 5: Control
Intervention					
Program Intervention	.36	.26	.27	.35	.18
Organizational Support Scales					
Formal Organ. Support Scale (FOS Total)		.01	.01	.04	.03
Informal Organ. Support Scale (IOS Total)		.00	.00	-.03*	-.02*
Student Role Stress Subscale					
Role Conflict (RC)			.05**	-.26	-.21
Student Role Stress Interactions					
FOS Total X RC				-.00	-.00
IOS Total X RC				.00**	.00**
Program Intervention X RC				--	--
Control					
STEM Major					1.78***
Constant	2.71	1.82	.59	8.39	5.73
F (for regression model)	1.67	1.97	3.28**	3.32**	18.87***
Change in F	1.67	2.10	7.02**	3.23*	101.15***
R^2	.01	.03	.07	.10	.42
Change in R^2	.01	.02	.04	.03	.32

Note: Unstandardized coefficients reported.
*p ≤ .05; **p ≤ .01; ***p ≤ .001.
Intervention Coded 1= CIC-SROP and 0 = OSROP.
STEM Major Coded 1= STEM Major and 0= Other Major.
-- Due to high levels of correlations between the variables, the interaction term was unable to be calculated in SPSS.
STEM Research Career Plans Scale: 1) *Completely certain I will not pursue a STEM research career*, 2) *Pretty certain I will not*, 3) *Some possibility I will*, 4) *Pretty certain I will*, and 5) *Completely certain I will*.

significant and positive ($p \leq .01$), with the informal support relationship strengthened for students experiencing lower levels of role stress.

For Model 5, all of the effects remained the same as in Model 4. In addition, STEM major was a statistically significant predictor ($p \leq .001$) of STEM Research Career Plans, with STEM students having significantly higher ratings for STEM Research Career Plans than their non-STEM peers. This model accounts for 42% of the variance, which shows that STEM major is the most powerful predictor of STEM Research Career Plans in the present study. Since the coefficients from Steps 1-4 did not change once STEM major was added to the STEM Research Career Plans model, it appears that the strong effect of STEM major does not reduce the direct effects of Informal Organizational Support. Moreover, the significant interaction also suggests that Informal Organizational Support may moderate the relationship between student role stress and STEM Research Career Plans.

2c: Stress Buffering Role of Adaptive Student Strengths

The final Research Question, 2c, seeks to better understand whether underrepresented students' adaptive strengths moderate the negative relationships between student role stress and successful STEM outcomes. To explore this question, hierarchical regressions included student role stress, adaptive strengths indicators, and relevant role stress by adaptive strengths interaction terms. In this section, results are presented from regression analyses that contain indicators of three adaptive strengths that are especially relevant for underrepresented students in pipeline interventions – personal resiliency, extended family support, and faith-based community engagement. Table 4.16 will first present the findings for Overall Program Satisfaction, followed by Table 4.17 with a focus on STEM Research Career Plans.

Prediction of Overall Program Satisfaction

Three sets of predictors were entered into the regression equation sequentially in Steps 1-3: program intervention, organizational supports, and student role stress, respectively. The three adaptive strengths predictors of personal resiliency, extended family support, and faith-based community engagement were entered in Step 4. In Step 5, the relevant stress by strengths interactions were entered (role overload by personal resiliency, role overload by extended family support, and role overload by faith-based community engagement). The results for each interaction are especially useful in exploring the buffering effects of adaptive student strengths on the negative relationship between student role stress and Overall Program Satisfaction.

Model 1 in the hierarchical regression (Table 4.16) explores intervention participation. It accounts for 3% of the variance in Overall Program Satisfaction, which is statistically significant from zero ($p \leq .01$). Again, this suggests that CIC-SROP participation enhanced UR students' program satisfaction, as they were more satisfied than the OSROP participants.

Model 2 adds formal and informal organizational support indicators to the analysis. Only formal organizational support is related to Overall Program Satisfaction ($p \leq .001$). When the specific organizational supports that are formally implemented in research opportunity programs are taken into account, the indicator for program participation is no longer a statistically significant predictor of variance in the outcome. Taken together, these results suggest that regardless of whether students are participating in CIC SROP or OSROP, formal organizational support is a significant predictor of Overall Program Satisfaction.

Model 3 adds the indicator for student role stress to the analysis. Controlling for program intervention and organizational supports, role stress is not a significant predictor of Overall Program Satisfaction. This model accounts for 23% of the variance in students' Overall Program

Table 4.16: Hierarchical Regression of the Predictive Relationships between Intervention, Organizational Support, Student Role Stress, Adaptive Strengths by Stress Interactions, and Overall Program Satisfaction (n = 186)

	Models for Overall Program Satisfaction				
Predictor Variables	Model 1: Program Intervention	Model 2: Organizational Support Subscales	Model 3: Student Role Stress Subscale	Model 4: Adaptive Strengths	Model 5: Interactions
Intervention					
Program Intervention	.23*	.12	.12	.12	.12
Organizational Support Scales					
Formal Organizational Support Scale (FOS Total)		.01***	.01***	.01***	.01***
Informal Organizational Support Scale (IOS Total)		.00	.00	.00	.00
Student Role Stress Subscale					
Role Overload Subscale (RO)			-.00	-.00	-.01
Adaptive Strengths					
Personal Resiliency (PR)				.00	.00
Extended Family Support (EFS)				.00	.01
Faith-Based Community Engagement (FCE)				-.01	-.04
Student Role Stress by Adaptive Strengths Interactions					
RO X PR					--
RO X EFS					.00
RO X FCE					.00
Constant	3.54	2.71	2.77	2.70	2.86
F (for regression model)	5.74*	18.37***	13.73***	8.01***	6.32***
Change in F	5.74*	23.96***	.09	.53	.54
R^2	.03	.23	.23	.24	.25
Change in R^2	.03	.20	.00	.01	.01

Note: Unstandardized coefficients reported.
*p ≤ .05; **p ≤ .01; ***p ≤ .001.
Intervention Coded 1= CIC-SROP and 0 = OSROP.
STEM Major Coded 1= STEM Major and 0 = Other Major.
-- Due to high levels of correlations between the variables, the interaction term was unable to be calculated in SPSS.
Overall Program Satisfaction Scale: 1= *Extremely Dissatisfied*, 2= *Somewhat Dissatisfied*, 3= *Somewhat Satisfied*, and 4= *Extremely Satisfied*.

Satisfaction, but there was no significant change in the explained variance from Model 2 to Model 3. Interestingly, formal organizational support remains a significant predictor ($p \leq .001$) of Overall Program Satisfaction after accounting for student role stress.

Model 4 accounts for 24% of the variance but does not show a substantial improvement in the amount of variance accounted for in the prior model. Model 4 suggests that after accounting for program intervention, organizational supports, and student role stress, adaptive student strengths do not significantly relate to Overall Program Satisfaction.

Model 5 includes the three student role stress interaction effects, explaining a significant proportion of variance in Overall Program Satisfaction. However, the formal organizational support variable remained the only significant predictor of students' overall satisfaction with their SROP experiences. Adaptive strengths do not appear to have a direct relationship to Overall Program Satisfaction, nor do they buffer students from the potentially negative effects of role stress on this satisfaction. It is important to note that while the coefficient for the relationship between student role stress and Overall Program Satisfaction is negative, it is not statistically significant.

Prediction of STEM Research Career Plans

As summarized in Table 4.17, the predictors for STEM Research Career Plans also were entered into the regression in five separate steps, consistent with Aim 2. The intervention variable was entered in Step 1 followed by formal and informal organizational support in Step 2, as in the prior hierarchical regression. Similarly, student role stress was entered in Step 3, while Step 4 was composed of three adaptive student strengths. Step 5 adds three role stress by adaptive strengths interaction terms (role stress by personal resiliency, role stress by extended family support, and role stress by faith-based community engagement). Again, the interaction

Table 4.17: Hierarchical Regression of the Predictive Relationships between Intervention, Organizational Support, Student Role Stress, Adaptive Strengths by Stress Interactions and STEM Research Career Plans (n = 186)

	STEM Research Career Models				
Predictor Variables	Model 1: Intervention	Model 2: Organizational Support Subscales	Model 3: Organizational Stress Subscale	Model 4: Adaptive Strengths	Model 5: Interactions
Intervention					
Program Intervention	.36	.26	.27	.31	.56
Organizational Support Scales					
Formal Organizational Support Scale (FOS Total)		.01	.01	.01	.01
Informal Organizational Support Scale (IOS Total)		.00	.00	.00	.01
Student Role Stress Subscale					
Role Conflict Subscale (RC)			.05**	.06**	.55
Adaptive Strengths					
Personal Resiliency (PR)				.02	.13
Extended Family Support (EFS)				.01	.28**
Faith-Based Community Engagement (FCE)				.04	.31
Student Role Stress by Adaptive Strengths Interactions					
RC X PR					-.00
RC X EFS					-.01**
RC X FCE					-.01
Constant	2.71	1.82	.59	-.92	-14.60
F (for regression model)	1.66	1.95	3.26**	2.39*	2.47**
Change in F	1.66	2.09	6.98**	1.21	2.50
R^2	.01	.03	.07	.09	.12
Change R^2	.01	.02	.04	.02	.04

Note: Unstandardized coefficients reported.
*p ≤ .05; **p ≤ .01; ***p ≤ .001.
Intervention Coded 1= CIC-SROP and 0 = OSROP. STEM Major Coded 1= STEM Major and 0= Other Major.
-- Due to high levels of correlations between the variables, the interaction term was unable to be calculated in SPSS.
STEM Research Career Plans Scale: 1) *Completely certain I will not pursue a STEM research career*, 2) *Pretty certain I will not*, 3) *Some possibility I will*, 4) *Pretty certain will*, and 5) *Completely certain I will*.

results help to explore possible buffering effects of adaptive student strengths on the potentially negative relationship between role stress and STEM Research Career Plans.

Model 1 in the hierarchical regression consists of the indicator for intervention participation (CIC-SROP vs. OSROP). This intervention participation variable accounts for just 1% of the variance in STEM Research Career Plans, but is not significantly significant. Similarly, in Model 2, formal and informal organizational support do not significantly predict STEM Research Career Plans, when controlling for program intervention.

Particularly relevant to Research Question 2c, adding the student role stress predictor in Model 3 did result in a statistically significant model ($p \leq .01$). Student role stress was the only significant predictor of STEM Research Career Plans ($p \leq .01$). As stress increases, career plans increase as well; on average, students with higher role stress also report more certainty about pursuing research careers in STEM.

None of the three adaptive student strengths predictors entered into Model 4 was significantly related to STEM Research Career Plans, but role stress remains a significant predictor. However, when the strengths by role stress interactions were entered in Model 5, the conditional effect for extended family support and the extended family support by role conflict interaction term were both statistically significant predictors ($p \leq .01$) of STEM Research Career Plans. As perceptions of extended family support increase, students' STEM Research Career Plans also increase, after controlling for other factors entered in Models 1 through 4. The significant interaction effects suggest that the positive relationship between extended family support and STEM Career Plans is even stronger among UR students experiencing higher levels of role stress.

CHAPTER V

SUMMARY AND DISCUSSION

Guided by a comprehensive strengths-based approach, the present study explored the complex relationships among organizational support, program satisfaction, and STEM outcomes among underrepresented students in exemplary pipeline interventions. In general, study findings: (a) produced a set of reliable and valid measures of both strong formal and informal organizational support useful for research on UR students in pipeline interventions, and (b) showed that SROP strong organizational support had clear relationships to overall program satisfaction, but less clear relationships to STEM research career plans.

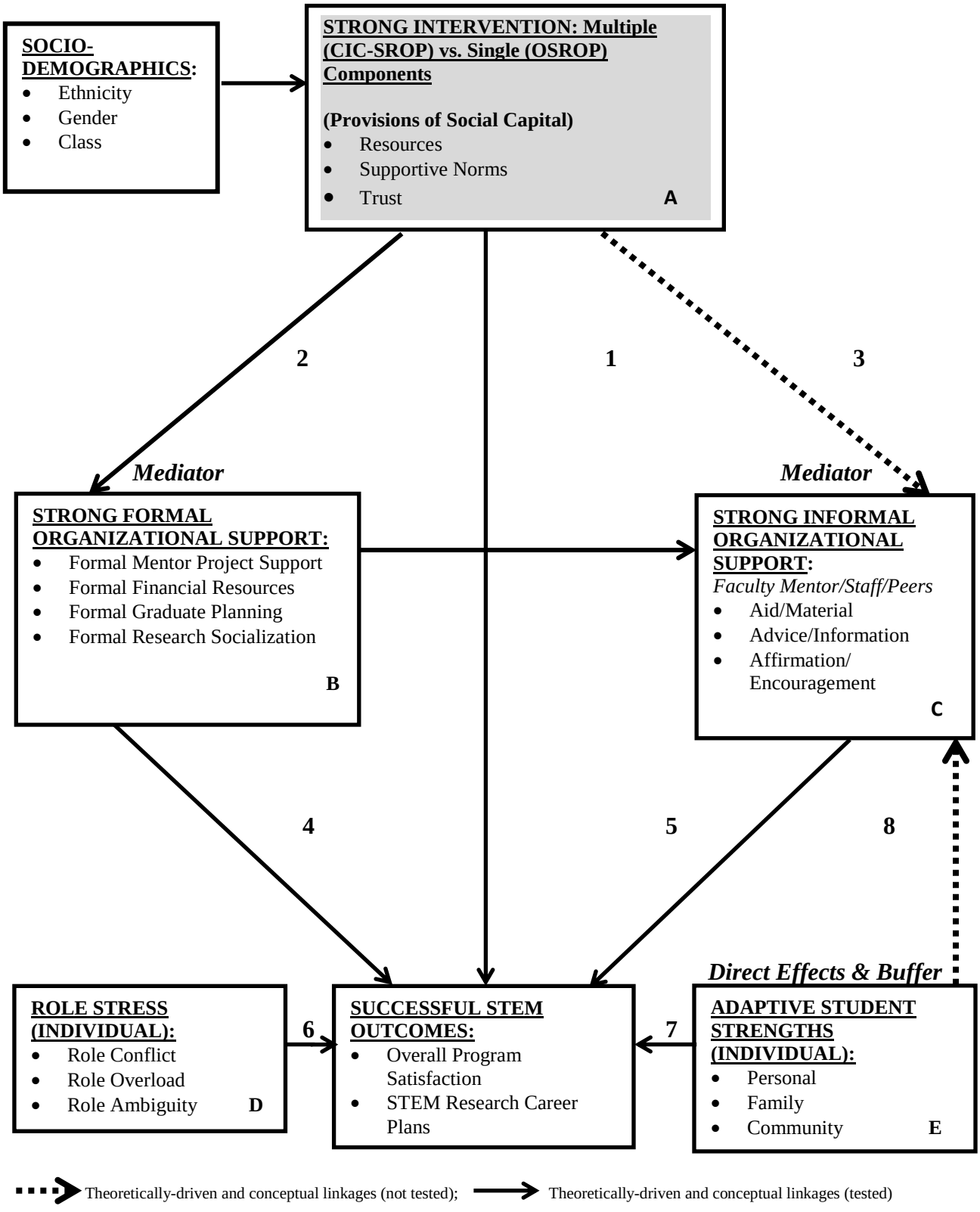
Several interesting findings emerged from the results of the seven specific research questions: (1) Are there policy-relevant ethnic and gender differences among SROP participants on specific items used to measure the multiple components of formal and informal organizational support*?* (2) Do UR students in more strongly designed CIC-SROP programs actually perceive higher levels of formal organizational support than those in OSROP interventions with fewer formal program components? (3) In addition to formal organizational support, do UR students in SROP interventions also benefit from strong informal organizational support from three major program sources – faculty mentors, staff, and peers? (4) Can formal and informal organizational support within pipeline interventions be measured with reliable scales and subscales representing multiple components? (5) In addition to strong program participation, do formal and informal

organizational support factors further enhance program satisfaction and successful STEM outcomes? (6) Are the effects of formal and informal organizational support on successful STEM outcomes stronger among pipeline intervention participants facing higher role stress? (7) In addition to strong organizational support, do adaptive strengths among pipeline intervention participants help to buffer any deleterious effects of role stress on successful STEM outcomes?

As outlined in Figure 5.1, this strengths-based study integrated insights from social capital, organizational support, and role strain theories to guide a more penetrating analysis of successful STEM outcomes among UR students (e.g., Bowman, 2006, 2011a, 2013; Davis, 2010; Lichtenstein, 2005; Rowley & Bowman, 2009). Strong formal and informal organizational support mechanisms are conceptualized as pivotal mediators between the provision of social capital in exemplary pipeline interventions and successful STEM outcomes. Rather than simply estimate a path analytic model, this study developed reliable measures of both strong formal and informal organizational support, and further clarified how the multiple components of strong organizational support and other adaptive strengths might operate to better explain successful outcomes among UR in pipeline interventions.

As indicated by the solid arrows in Figure 5.1, the results provide new insight into how strong intervention social capital operated through both strong formal and informal organizational support which, in turn, can help to better explain successful outcomes among UR students in pipeline interventions (Coleman, 1988; Lee, 2003; St. John & Fisher, 2011; Trent & St. John, 2008). In addition to the direct impact of intervention participation, my comprehensive findings build on past strengths-based studies to further clarify how organizational support might combine with adaptive strengths to help better explain successful intervention outcomes among UR students faced with high role stress (Hrabowski et al., 1998, 2003; Maton et al., 2000, 2004).

Figure 5.1: Intervention Social Capital, Organizational Support, and STEM Outcomes: A Refined Strengths-Based Role Stress and Adaptation Approach



Strong Organizational Support: Conceptual and Measurement Issues

Findings show how UR students within the strongly designed CIC-SROP perceived higher levels of formal organizational support than students within other SROP interventions with fewer formal components. As shown in Figure 5.1 (arrow 2), my findings support the importance of program social capital elements in strong pipeline interventions for UR students. As outlined within Box A in Figure 5.1, CIC-SROP was designed as a comprehensive pipeline program to provide strong social capital including supportive resources, supportive norms, and trust (e.g., Allen & Zepeda, 2007; Davis, 2007; Davis, 2008; Foertsch, Alexander, & Penberthy, 2000; Girves, Zepeda, & Gwathmey, 2005; Zepeda, 2010). Therefore, strong social capital features such as supportive networks (Lin, 1999; Portes, 1998), information sharing (Coleman, 1994), and information channels (Farmer-Hinton & Adams, 2006) that facilitate the social exchange of resources, norms, and trust appear to operate through CIC-SROP and OSROP differences in the multiple components of strong formal organizational support.

Strong Formal Organizational Support

Factor analysis results clearly showed that SROP strong formal organizational support can be measured with reliable scales that include empirically distinguishable subscales representing four formal components. As outlined within Box B in Figure 5.1, rather than the hypothesized five components, three formal organizational support components emerged from my analysis; however, based on interpretability issues four subscales were used in subsequent analyses: Formal Research Mentor Support, Formal Financial Resources, Formal Graduate Planning, and Formal Research Socialization. Social psychological theory and research on organizations have long shown that perceived organizational support – both formal and informal – promotes successful organizational and individual outcomes (e.g., Kahn, Wolfe, Quinn, Snock,

& Rosenthal, 1964; Katz & Kahn, 1978; Eisenberger & Stinglhamber, 2011). In terms of formal organizational support, comprehensive pipeline programs appear to provide a strong network and a wide range of resources as supportive intervention components. Therefore, as expected, CIC-SROP participants had significantly higher scores compared to the OSROP participants on the Formal Organizational Support Composite scale, and three of the four subscales - Formal Financial Resources, Formal Graduate Studies Planning and Formal Research Socialization. However, there was no statistically significant difference between CIC-SROP and OSROP participants on the Formal Research Mentor Support subscale. This suggests that the types of formal support provided by faculty mentors are equally strong within CIC-SROP and other faculty mentored summer research experiences for undergraduates. However, CIC-SROP participants appeared to benefit from the stronger level of formal support provided by the multiple program components.

Strong Informal Organizational Support: Faculty Mentor, Staff, and Peers

As highlighted within Box C in Figure 5.1, factor analysis results clearly show how SROP strong informal organizational support can be measured with reliable scales that include empirically distinguishable subscales representing three informal components. Consistent with related studies, my findings on UR students in SROP interventions also show substantial construct validity for the three expected components of informal organizational support – Aid, Advice and Affirmation (e.g., Ebreo, 1998; House, 1974; House, Umberson, & Landis, 1988). The hypothesized three informal organizational support components emerged for both faculty mentor and program staff. However, only two of the three were obtained for program peers where the Advice/Affirmation components emerged as a single informal support subscale. The finding that program peers were consistently perceived as a more trusted source for all three

types of informal organizational support than either faculty mentors or program staff should be a major focus for future research. A growing number of related studies further suggests that future research should clarify the implications of such strong levels of informal peer support for better understanding the relationships between peer mentoring strategies and successful STEM outcomes (Bolling et al., 1988; Cohoon & Aspray, 2006; Friedman & Kay, 1990; Good et al., 2000; Goodman, 2002; Landis, 1995; Marable, 1999; Reichert & Absher, 1997; Stewart, 1990).

Intercorrelations among Major Research Variables Linked to Policy-Relevant Theoretical Issues: Implications for Future Research

Ethnic and Gender Differences in Organizational Support

In general, there were clear ethnic differences, and less clear gender differences, in how UR students experienced various components of formal and informal organizational support. In terms of ethnic patterns, URM consistently perceived SROP formal and informal organizational support in more positive ways than White and other Non-URM students. When the few gender differences occurred, it was males who tended to perceive higher levels of formal and informal organizational support than females, with one exception. In contrast to all other types of organizational support, females perceived higher levels of informal peer support than males on several specific Advice and Affirmation items.

Future research should seek to clarify why URM students perceived stronger levels of support than non-URM students. Consistent with a stress-buffering hypothesis, perhaps the more marginalized URM students more highly valued the SROP organizational support provided. Or perhaps the historical racially-targeted SROP intervention design is still more sensitive to URM than non-URM participants, who increasingly gain access to pipeline interventions because of class or economic disadvantages. Another possibility is that URM perceive less negative stigma

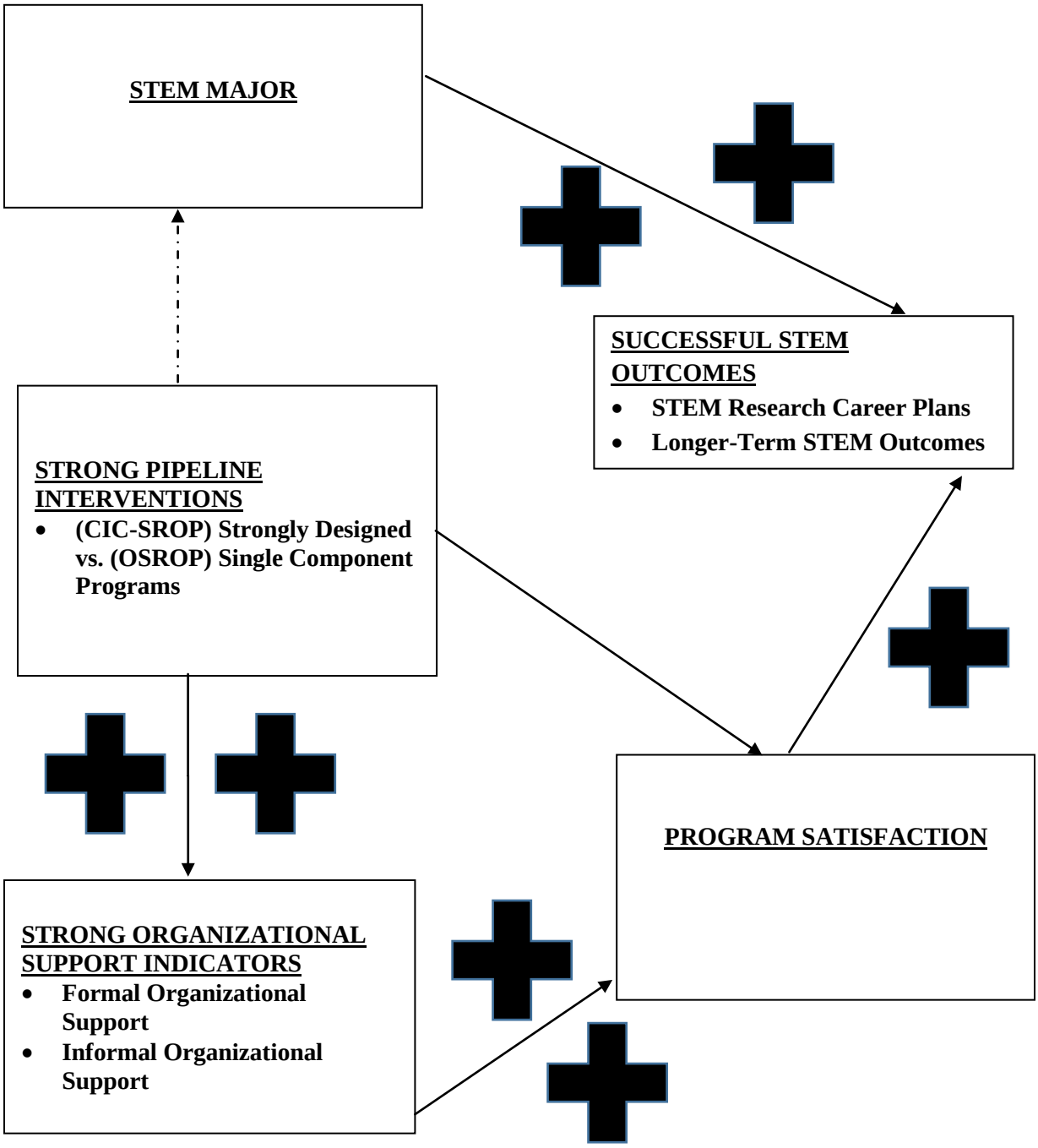
from participation in pipeline interventions that were historically "race-targeted" compared to Whites and non-URM. Future studies on both groups should direct more attention to disaggregating traditional racial/ethnic categories and exploring the variation among increasingly diverse subgroups in various STEM fields. Finally, future STEM research to further clarify current gender findings should consider several plausible explanations including gender-specific peer support patterns among women, stress-buffering patterns among especially marginalized URM males, and other possible gender-race interactions (Clewell & Campbell, 2002; Hrabowski et al., 1998, 2003; Maton et al., 2003).

Organizational Support, Program Satisfaction and Successful STEM Outcomes

In addition to objective SROP intervention effects, do formal and informal organizational support factors further enhance successful STEM outcomes? The current study findings on this question provided no evidence of clear direct effects of either the CIC-SROP intervention (compared to OSROP) or organizational support on STEM research career plans. However, there are several related findings in this exploratory study that provide some interesting direction for future pipeline intervention design and related research.

As seen in Figure 5.2, the findings show: (a) very strong relationships between CIC-SROP and Strong Organizational Support (++), (b) very strong relationships between Strong Formal Organizational Support and Program Satisfaction (++), (c) significant but more modest relationships between Program Satisfaction and STEM Research Career Plans (+), and (d) very strong relationships between STEM Major and Research Career Plans (++). These relationships are indicated by the presence of one or two plus-signs along the arrows connecting each box. Therefore, guided by these findings, strong STEM pipeline interventions should be designed to reinforce STEM major persistence, strong organizational support, and program satisfaction.

Figure 5.2: Model for Future Research on Relationship between Strong Pipeline Intervention and Successful STEM Outcomes



In addition, future research should go beyond short-term STEM research career plans to also focus on students' STEM major persistence and longer-term STEM outcomes.

Future research should also build on findings from the current study to further clarify the relationships among specific components of strong formal and informal organizational support, program satisfaction, and a range of longer-term STEM outcomes. Past research by Johnson (2005) suggests that formal and informal organizational support in undergraduate pipeline programs increases success in both graduate studies and professional careers. There is a need to better understand how formal organizational support promotes successful admissions and success in STEM graduate programs. In contrast, informal organizational support from faculty and peers may be most critical in helping UR students better refine their STEM career goals and bolster their STEM career self-efficacy and research career identity. Future studies on pipeline programs at difference stages of STEM career development should direct more focus on the type of prior education, pipeline intervention, and research experience(s) that UR student participants have accumulated over the years. This is especially critical for understanding the effects of highly competitive and short-term pipeline interventions such as SROP.

Implications for STEM Program Practice and Policy

The current study findings in support of a more comprehensive strengths-based approach to pipeline research on UR students also have important policy implications for STEM talent development and the national competitiveness of the United States in the 21st century. For example, Bowman (2011b) noted:

> There is a growing recognition that America's future depends not only on attracting more skilled international talent, but also on closing cross-national achievement gaps between the United States and currently higher performing Asian and European nations

> through more comprehensive talent development strategies for all racial/ethnic, socioeconomic, and gender groups. America's competitiveness in the 21st century requires more strategic investment in talent development among historically underrepresented groups [in STEM]. There is growing collaboration among several non-profits and governmental agencies to support more comprehensive approaches to understanding and improving interventions that promote success among minorities and women. (p. 5-6)

The strengths-based findings on systematic measurement of the multiple components of strong organizational support, and their relationship to successful STEM outcomes among UR students within exemplary pipeline programs, have important implications for both program innovation and policy. At the program level, findings on UR students in SROP interventions build on prior research on the exemplary Meyerhoff Scholars Programs and comprehensive Research Opportunity Programs.

Research-to-Practice Implications

Meyerhoff Scholars Program Similarities: The findings of this study on the importance of systematic research on multiple components of formal and informal organizational support as well as adaptive strengths are consistent with related studies on the Meyerhoff Scholars Program (Hrabowski et al., 1998, 2003; Maton et al., 2000, 2004). Both the current and related studies support the importance of strengths-based pipeline programs providing UR students with stronger social capital and comprehensive organizational support systems that are responsive to the adaptive strengths that the students bring to intervention settings. Similar to Meyerhoff studies, this study reinforced the importance of strong program designs that provide multiple components of formal organizational support, including faculty mentors, financial aid, higher

education and career planning, and career-related socialization and enrichment activities. Maton and colleagues (Maton et al., 2000, 2004) supported the important role of program staff, including formal advising and monitoring activities designed for the early detection of problems, reinforcing high expectations, and providing more on-time informal support whenever needed to promote effective problem-solving, program satisfaction, persistence, and long-term success.

The present study demonstrates the significance of comprehensive programs that combine strong formal organizational support with strong informal peer support systems and adaptive strengths among UR students themselves. Rather than a narrow focus on student deficits, studies by Hrabowski and colleagues (1998, 2002, 2009) foreshadowed the findings on the importance of strong informal support from peers, extended family, community sources, and personal resiliency for successful outcomes among UR students, who often must overcome systematic barriers as they strive for success in STEM interventions, education, and careers. Therefore, higher education institutions can build on these findings to further improve the efficacy of STEM pipeline interventions that are focused on ameliorating achievement gaps and disparities at the PK–12, undergraduate, graduate, postdoctoral, and career levels.

CIC-SROP Implications for Strong Student and Career Development Interventions: In addition to the Meyerhoff Scholarship Program, this research on the exemplary CIC-SROP has important implications for the design of other strong research opportunity initiatives, PK-20 pipeline programs, and higher education student and career development interventions to promote successful outcomes among UR students who face systematic barriers (e.g., Bowman, 2006; 2011a; 2013). The strengths-based model guiding this study helps to further clarify how CIC-SROP was systematically designed, structured and organized as a strong pipeline intervention with multiple program components. In contrast to single-component pipeline

interventions, CIC-SROP and other strong research opportunity interventions are increasingly recognized as having an especially high impact on UR students (Cole, 1995; Kuh et al., 1991; Millspaugh & Millenbah, 2004; Randall, Wilbur, & Burkholder, 2004; Thompson, McNeill, Sherwood, & Starck, 2001).

Going beyond traditional deficit thinking, the strengths-based findings in the present study clarify the importance of CIC-SROP and other strong pipeline interventions that provide social capital such as multiple resources, supportive norms among committed program staff, and a supportive program habitat characterized by interpersonal trust among mentors, staff, and participants (e.g., Coleman, 1988; St. John, Hu & Fisher, 2011; Trent & St. John, 2008). The present findings on CIC-SROP can guide the design of strong student and career development interventions for UR students, where strong social capital at the program level systematically promotes: (1) strong formal organizational support where students express satisfaction with multiple program components; (2) strong informal organizational support from multiple sources that provides students with aid, advice, and affirmation whenever needed; and (3) the mobilization of adaptive strengths among UR students themselves that facilities active coping, resiliency, and empowerment despite stressful barriers in their pathways to higher education and career success (Bowman, 2011a; Ebreo, Fonseca-Bolorin, & Bowman, 2011).

The strengths-based findings on CIC-SROP have particular implications for the design of strong research opportunity interventions including both intensive summer or short-term interventions (Aguirre, 1993; Davis, 2006; Eatman, 2002; Foertsch et al., 1997; Foertsch et al., 2000; Gaffney, 1993; Johnson, 2005; Vance, 1993) and longer-term mentored research opportunities for one full year or more (Hunter, Laursen, & Seymour, 2007; Seymour, 2001). Regardless of duration, the CIC-SROP findings support the importance of strong research

opportunity interventions that provide participants not only with access to appropriate research facilities but also with strong organizational support that includes an array of formal resources, enrichment activities, and informal support from faculty mentors, program staff, and peers.

Finally, the CIC-SROP findings provide clear guidance for the NIH, NSF, U.S. Department of Education, foundations, non-profits, universities and other policy-relevant stakeholders on the design of strong pipeline interventions to promote STEM careers among UR students in the interest of both talent development and global competitiveness. The CIC-SROP findings place the emphasis on the strengths-based design and implementation of a strong social organization in research opportunity interventions. A strong social organization provides UR students with the opportunity to engage in a relevant research project with appropriate facilities, under strong faculty mentorship, accompanied by both strong formal support from multiple program components and strong informal support from faculty mentors, program staff, and peers. Such program organization elements can, in turn, promote the mobilization of adaptive student strengths, improve academic performance and research career competencies, and motivate advanced higher education and career strivings, especially for UR students faced with systematic barriers.

APPENDICES

APPENDIX A

STRONG INFORMAL ORGANIZATIONAL SUPPORT

Title: Strong Informal Organizational Support Measure

Reference: Vaux, A., Riedel, S., & Stewart, D. (1987). Modes of social support: The social support behaviors (SS-B) scale. *American Journal of Community Psychology*, *15*(2), 209-232.

Operational Definition of Strong Informal Organizational Support Measure

Modified from Ebreo (1999), the Strong Informal Organizational Support variables used in this analysis consisted of: a measure of perceived informal support in the form of aid/material/technical assistance assessed by actual self-reports on a 5-point scale (1 = *definitely no*, 2 = *probably no*, 3 = *maybe*, 4 = *probably yes*, 5 = *definitely yes*); a measure of perceived informal support in the form of advice/guidance/information assessed by actual self-reports on a 5-point scale (the same categories as above); and a measure of perceived informal support in the form of affirmation/socio-emotional encouragement/socialization assessed by actual self-reports on a 5-point scale (the same categories as above).

Specific Questions

Instructions: RESEARCH MENTORS in summer research experiences, project directors, lab managers, and other STAFF affiliated with a research program, and OTHER STUDENTS affiliated with the research program you attended this past summer may have helped students in different ways. Suppose you had a problem (upset about something, just needed to talk with someone, needed advice, were broke or had a practical problem).

Base your answer on YOUR PERCEPTIONS or your PAST EXPERIENCE. Use the scale below and check one number to indicate your views.

1	2	3	4	5
Definitely yes	**Probably yes**	**Maybe**	**Probably no**	**Definitely no**

Question: Would your RESEARCH MENTOR help you out in the specific ways listed below? My RESEARCH MENTOR would:

a. Visit or come around me more
b. Comfort me if I was upset
c. Give me a ride if I needed one
d. Have lunch or dinner with me
e. Look after my belongings for a while
f. Loan me a car if I needed one
g. Joke around or suggest doing something to cheer me up
h. Go to a movie, concert, or other social event with me
i. Suggest how I could find out more about a situation
j. Listen if I needed to talk about my feelings
k. Have a good time with me
l. Give me advice about what to do
m. Chat with me
n. Help me figure out what I want to do
o. Show me that they understand how I was feeling
p. Call me just to see how I was doing
q. Help me out with some necessary purchase
r. Loan me money for an indefinite period
s. Be sympathetic if I was upset
t. Buy me clothes if I was short of money
u. Tell me about available choices and options
v. Loan me tools, equipment, or appliances when I needed them
w. Show affection for me
x. Show me how to do something I didn't know how to do
y. Bring me little presents of things I needed
z. Loan me money and want to "forget about it"
aa. Tell me what to do
bb. Offer me a place to stay for a while
cc. Loan me a fairly large
dd. sum of money (say equivalent to a month's rent)
ee. Help me decide what to do

Question: Would STAFF MEMBERS affiliated with your research experience help you out in the specific ways listed below? STAFF MEMBERS affiliated with my research experience last summer would:

a. Visit or come around me more
b. Comfort me if I was upset
c. Give me a ride if I needed one
d. Have lunch or dinner with me
e. Look after my belongings for a while
f. Loan me a car if I needed one
g. Joke around or suggest doing something to cheer me up

h. Go to a movie, concert, or other social event with me
i. Suggest how I could find out more about a situation
j. Listen if I needed to talk about my feelings
k. Have a good time with me
l. Give me advice about what to do
m. Chat with me
n. Help me figure out what I want to do
o. Show me that they understand how I was feeling

Question: Would OTHER STUDENTS affiliated with your research experience help you out in the specific ways listed below? OTHER STUDENTS affiliated with my research experience last summer would:

a. Visit or come around me more
b. Comfort me if I was upset
c. Give me a ride if I needed one
d. Have lunch or dinner with me
e. Look after my belongings for a while
f. Loan me a car if I needed one
g. Joke around or suggest doing something to cheer me up
h. Go to a movie, concert, or other social event with me
i. Suggest how I could find out more about a situation
j. Listen if I needed to talk about my feelings
k. Have a good time with me
l. Give me advice about what to do
m. Chat with me
n. Help me figure out what I want to do
o. Show me that they understand how I was feeling

APPENDIX B

ROLE STRESS

Title: Role Stress Measure

Reference: Bernhard, E. (1997). *Gender differences in role stress: Role ambiguity, conflict and overload during the college transition.* Unpublished dissertation, Northwestern University.

Operational Definition of Role Stress Measure

The measure of organizational stress is based on a 26-item Student Role Stress Scale which has demonstrated reliability and validity in an undergraduate student sample (Bernhard, 1996). This organizational strain measure was adapted from a standard theory-driven scale that assesses three critical dimensions of student role-related academic strain-role overload, conflict, and ambiguity (Coverman, 1989; Kelloway & Barling, 1990; Kahn & Byosiere, 1992; King & King, 1990; Tracy & Johnson, 1981). The assessing student role overload, conflict, and ambiguity provided the following instructions and response categories: "Please indicate how often you have experienced the following situations THIS PAST SCHOOL YEAR." Participants responded to the items using a 5-point scale (1 = never, 2 = almost never, 3 = sometimes, 4 = fairly often, and 5 = very often).

Instructions: Please indicate how often you have EXPERIENCED the following situations THIS PAST SCHOOL YEAR.

1	2	3	4	5
Never	**Almost never**	**Sometimes**	**Fairly often**	**Very often**

a. I am given enough time to do what is expected of me in classes
b. I feel secure about the respect I receive from my teachers
c. I receive assignments without the background to complete them
d. Clear, planned goals and objectives exist for my courses
e. I have two or more classes which operate quite differently
f. I know that I have used my study time properly
g. I have to ignore a rule or policy to carry out class assignments
h. It often seems like I have too much class work for one person to do
i. I know what my responsibilities are as a student
j. I receive incompatible requests from two or more teachers

k. I know exactly what is expected of me in classes
l. I do things that are apt to be accepted by one teacher and not accepted by others

APPENDIX C

ADAPTIVE STRENGTHS

Title: Adaptive Strengths Measure

References:

Cunningham, B. K. (1984). *Religious orientation as a coping resource*. Unpublished Doctoral Dissertation, University of Michigan.

James, S. A., Hartnett, S. A., & Kalsbeek, W. D. (1983). John Henryism and blood pressure differences among black men. *Journal of Behavioral Medicine, 6*(3), 259-278.

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

Operational Definition of Adaptive Strengths Measure

Data were collected using carefully designed survey questions based of extant evaluation studies on the SROP that provided a wide range of measures in several areas – **personal resiliency, extended family support network, and faith-based community engagement.** The Adaptive Strengths variables used in this analysis were:

The measure of **personal resilience** illustrated through the symbolic representation of Sojourner Syndrome (Mullings, 2002) and modified from the John Henryism Scale (James, Hartnett, & Kalsbeek, 1983). The measure listed 12 items that represent hard work and determination despite obstacles and oppressive circumstances. Participants responded to the items using a 4-point scale (1 = completely false, 2 = mostly false, 3 = mostly true, and 4 = completely true).

The measure of **extended family support** was adapted from the Extended Family Support Scale (Reyes, 2002). The measure listed 15 items that represent the level of supportiveness extended family (e.g., "female cousin you feel closest to") would provide to participants in pursuit of the Ph.D. degree. Participants responded to the items a using 5-point scale (1 = does not apply, 2 = extremely supportive, 3 = very supportive, 4 = somewhat supportive, 5 = not at all supportive). Reyes (2002) provided initial psychometric support for a related scale that examined the degree of perceived support available from three family subsystems (one's nuclear family, blood kin,

and para-kin). Respondents rated each of 15 different extended family members in terms of "perceived closeness," "helpfulness in times of need," and "frequency of contact."

A 4-item index assessed **faith-based community engagement** among URM students as they managed organizational role strain as participants in research opportunity interventions. A growing number of studies suggests that each item represents a source of adaptive cultural strength among African Americans, Latinos, and other students of color (Cunningham, 1984; Jennings & Clarke, 2008; Taylor, Chatters, & Levin, 2004).

Instructions: Rate the degree to which the following statements are TRUE FOR YOU (personally).

1	2	3	4
Completely false	**Mostly false**	**Mostly true**	**Completely true**

a. I've always felt that I could make my life pretty much what I wanted to make out of it
b. Once I make my mind up to do something, I stay with it until the job is completely done
c. I like doing things that other people thought could not be done
d. When things don't go the way I want them to, that just makes me work even harder
e. Sometimes I feel that if anything is going to be done right, I have to do it myself
f. It's not always easy, but I manage to find a way to do the things I really need to get done
g. Very seldom have I been disappointed by the results of my hard work
h. I feel that I am the kind of individual who stands up for what he/she believes in, regardless of the consequences
i. In the past, even when things got really tough, I never lost sight of my goals
j. It's important for me to be able to do things the way I want to do them rather than the way other people want me to do them
k. I don't let my personal feelings get in the way of doing a job
l. Hard work has really helped me to get ahead in life

1	2	3	4	5
Does not apply	**Not at all supportive**	**Somewhat supportive**	**Very supportive**	**Extremely supportive**

Question: How SUPPORTIVE would the following people be if you decided to PURSUE a Ph.D. degree? Check the number that represents the level of SUPPORTIVENESS of each person.

a. Mother/stepmother
b. Father/stepfather
c. Sister
d. Brother
e. Grandmother you feel closest to
f. Grandfather you feel closest to
g. Aunt you feel closest to
h. Uncle you feel closest to
i. Female cousin you feel closest to

j. Male cousin you feel closest to
k. Best female friend
l. Best male friend
m. Adult at past high school you feel closest to
n. Adult member of your place of worship you feel closest to
o. Other adult "friend or family" you feel closest to

1	2	3	4	5
All/ Almost all persons of other ethnic groups	**Mostly persons of other ethnic groups**	**About half of my ethnic group & half other ethnic groups**	**Mostly persons of my ethnic groups**	**All/ Almost all - persons my ethnic groups**

Instructions: Rate the degree to which the following statement is TRUE FOR YOU (personally).

(1) Your place of worship (e.g., church, temple, mosque, etc.) (if you attend)

1	2	3	4	5
Very strongly disagree	**Strongly disagree**	**Neither agree nor disagree**	**Strongly agree**	**Very strongly agree**

Instructions: Please indicate how much you personally agree or disagree with each of the following items about family, religion, and other attitudes.

(2) I consider myself a very religious person
(3) I pray on a regular basis – daily or whenever I get a chance
(4) I attend church or religious services regularly – weekly or whenever I get a chance

APPENDIX D

EMPIRICALLY WORDED RESEARCH QUESTIONS

AND ASSOCIATED HYPOTHESES

Research Aim 1: This first aim of this study was to build on a comprehensive strengths-based framework to develop reliable and valid measures of strong formal and informal organizational support that are useful for research on UR undergraduate students in summer research pipeline interventions. More specifically, the results were used for measure development.

(1a) What are the ethnic and gender differences among pipeline intervention participants on specific items used to measure the multiple components of formal organizational support? To accommodate the parameters of the statistical analyses, this research question was divided into two empirically-oriented research sub-questions.

> *What are the ethnic differences among pipeline intervention participants on specific items used to measure the multiple components of formal organizational support?*
>
> *What are the gender differences among pipeline intervention participants on specific items used to measure the multiple components of formal organizational support?*

The sub-questions were assessed via the ANOVA procedure. Table 4.1 presented results from the analysis. Results from testing the statistical assumptions for ANOVA are presented in Appendix E.

(1b) Do UR students in the more strongly designed CIC-SROP programs actually perceive higher levels of formal organizational support than UR students in other pipeline interventions with fewer formal program components?

> *How do URM students perceive levels of formal organizational support within strongly designed pipeline interventions (in CIC-SROP programs) compared to pipeline interventions with fewer formal components (OSROP)?*

A series of independent *t*-tests was conducted to compare CIC-SROP and OSROP participant responses on the items designed to assess Formal Organizational Support. Results from the analysis are summarized in Table 4.2. Results from testing the statistical assumptions for *t*-tests are presented in Appendix E.

(1c) In addition to formal organizational support, do UR students in SROP interventions also benefit from strong informal organizational support from three major program sources – faculty mentors, staff and peers?

> *How do URM students perceive levels of strong informal organizational support within strongly designed pipeline interventions compared to pipeline interventions with fewer formal components?*

The repeated measures ANOVA procedure was conducted to assess differences across the three major informal program components. Results from the analysis are summarized in Table 4.3. Details regarding the test of statistical assumptions for ANOVA can be found in Appendix E.

(1d.1) Can strong formal and informal organizational support within pipeline interventions be measured with reliable and valid scales that include empirically distinguishable subscales representing multiple components? To accommodate the parameters of the statistical analyses, this research question was divided into four empirically oriented research sub-questions. Two questions pertained to examining validity and two questions pertained to

assessing reliability. Each question was evaluated using a different statistical procedure. Details for each sub-question and associated analyses are presented in the paragraphs below.

> *To what degree do the hypothesized scales of formal organizational support emerge empirically as separate and distinct latent factors for the SROP participant data collected in this study?*

This sub-research question was assessed using exploratory factor analysis (EFA). Table 4.4 presents a summary of the results from the factor analysis of the formal organizational support (FOS) items. Details regarding the results from testing the statistical assumptions are presented in Appendix E.

> *To what degree do the observed factors of informal organizational support scales emerge empirically as separate and distinct latent factors for the SROP participant data collected in this study?*

This sub-research question was assessed using exploratory factor analysis. An EFA was performed for each of the three scales (faculty mentor, staff, and peers) contained in the Informal Organizational Support (IOS) Scale. Details regarding the results from testing the statistical assumptions are presented in Appendix E. Results are presented in Tables 4.5, 4.6, and 4.7.

> *What is the reliability of the data collected from the strong pipeline intervention formal organizational support scales?*

This research question was addressed through the use of a reliability analysis. The coefficient alphas and means for the Formal Organizational Support Scale are presented in Table 4.8. There are no statistical assumptions associated with the reliability analysis.

> *What is the reliability of the data collected from the strong pipeline intervention formal and informal organizational support scales?*

This research question was addressed with a reliability analysis. The coefficient alphas and means for the IOS Scale are presented in Table 4.9. There are no statistical assumptions associated with the reliability analysis.

(1d.2) Can formal organizational support scales and subscales help to better clarify *meaningful differences* between strong CIC-SROP and OSROP interventions?

> *What are the differences between participants in the strong CIC-SROP and OSROP interventions on the formal organizational support scales?*

This question was tested via the ANOVA procedure. Table 4.10 presents the results from the analysis. Results from testing the statistical assumptions for ANOVA are presented in Appendix E.

(1d.3) Is there a significant relationship between strong formal and informal organizational support scales?

> *What are the relationships between formal and informal organizational support measures and the two dependent variables in this study?*

This research question was addressed with a correlation analysis. Results from the correlation analysis are presented in Table 4.11. There are no statistical assumptions associated with a correlation analysis.

Research Aim 2: This second aim of this study was to explore in greater detail a set of strengths-based predictive relationships to further establish the validity of the formal and informal organizational support scales described above. More specifically, the results were used to explore how strong formal and informal organizational support measures explain overall program satisfaction and successful STEM outcomes among UR students in summer research pipeline interventions.

(2a) In addition to objective pipeline intervention participation, do formal and informal organizational support factors further enhance program satisfaction and successful STEM outcomes?

How well do objective pipeline intervention participation formal organizational support scale scores, informal organizational support scale scores, STEM major, and STEM major interactions predict program satisfaction?

This sub-question was assessed via hierarchical linear regression (HLR) procedures. Results from testing the statistical assumptions for HLR are presented in Appendix E.

How well do objective pipeline intervention participation formal organizational support scale scores, informal organizational support scale scores, STEM major, and STEM major interactions predict STEM research career plans?

The sub-question listed above was assessed via the HLR procedures. Table 4.12 presents results from the analysis for predicting overall program satisfaction. Table 4.13 presents results of the analysis for predicting STEM career plans. Results from testing the statistical assumptions for HLR are presented in Appendix E.

(2b) Are the effects of formal and informal organizational support on successful STEM outcomes stronger among pipeline intervention participants facing higher role stress?

To what degree do pipeline intervention participation, organizational support, adaptive strengths, role stress, and role stress interactions by adaptive strengths among pipeline intervention participants predict overall program satisfaction?

To what degree do pipeline intervention participation, organizational support, adaptive strengths, role stress, and role stress interactions by adaptive strengths among pipeline intervention participants predict STEM research career plans?

The sub-questions listed above were assessed via the HLR procedures. Table 4.14 presents results from the analysis for predicting overall program satisfaction. Table 4.15 presents results from the analysis for predicting STEM career plans. Results from testing the statistical assumptions for HLR are presented in Appendix E.

(2c) In addition to strong organizational and informal organizational support, do adaptive strengths among pipeline intervention participants help to buffer any deleterious effects of role stress on their successful STEM outcomes?

To what degree do formal and informal organizational supports, pipeline intervention participation, STEM major, adaptive strengths, role stress, and role stress interactions among pipeline intervention participants predict overall program satisfaction?

To what degree do formal and informal organizational supports, pipeline intervention participation, STEM major, adaptive strengths, role stress, and role stress interactions among pipeline intervention participants predict STEM research career plans?

The sub-questions listed above were assessed via the HLR procedures. Table 4.16 presents results from the analysis for predicting overall program satisfaction. Table 4.17 presents results from the analysis for predicting STEM research career plans. Results from testing the statistical assumptions for HLR are presented in Appendix E.

APPENDIX E

PRESCREENING DATA AND ADDRESSING STATISTICAL ASSUMPTIONS

When conducting quantitative research, researchers must take actions to address the accuracy and validity of data collected for the study, which affect how the results are interpreted. Researchers need to prescreen data and test appropriate statistical assumptions before performing the data analysis procedures. This appendix discusses procedures taken to do so

Prescreening Data. When conducting quantitative data analysis, the data first should be prescreened to assess their accuracy and validity. The quality of the collected data affects the appropriateness and accuracy of the statistical procedures that are performed, and the subsequent interpretations made from the statistical analyses (Mertler & Vannatta, 2005; Onwuegbuzie & Daniel, 2003). The prescreening phase of data analysis should assess the following: the level of measurement for the dependent variable; the adequacy of the sample size for conducting statistical analyses; the accuracy of data collected; and the degree to which the assumptions have been met for each statistical procedure (Mertler & Vannatta, 2005).

Scale of Measurement. The scale of measurement assumption is based on the notion that data collected for the dependent variable must be measured on the interval or ratio level (Howell, 2004). The dependent variables in this study were overall program satisfaction and STEM career plans. Each of the variables were measured on the interval level as scores ranging from 1 to 5. Therefore the scale of measurement assumption was met.

Missing Data. When prescreening the data, researchers must address the issue of how to handle missing data responses (Stevens, 2009). Missing data is problematic in research because it affects the generalizability of findings, decreases the amount of usable data, and ultimately decreases the power associated with a statistical test (Mertler & Vannatta, 2005; Stevens, 2009). Researchers must therefore make an a priori determination of how to handle missing data and summarize the steps taken to mitigate the effects of missing data. I handled missing data in this study using the list-wise deletion procedure in SPSS. Before doing so I assessed the degree to which deleting cases might affect the results of statistical tests. To make this judgment I also assessed the adequacy of the resultant sample size for conducting the specified statistical procedure. This analysis revealed that using the list-wise deletion of cases with missing values did not affect the adequacy of the resulting sample size or the power of the statistical procedure.

ANOVA Analysis

I used the ANOVA procedure to address the sub-questions associated with Research Aim 2. The ANOVA procedure was chosen over independent *t*-tests because the ANOVA procedure is:

> (1) appropriate when there are more than two scores of the dependent variable or when there are more than two groupings on the independent variable (Howell, 2004; Mertler & Vannatta, 2005). In this study there were two scores for the dependent variable. The independent variable consisted of scores from several measures; the measure of Formal Organizational Support had five scale scores, and the measure of Informal Organizational Support had three scale scores. There were three subscale scores associated with each Informal Organizational Support scale.
>
> (2) more efficient than the independent *t*-tests, it can address simultaneous

comparisons between two or more means (Howell, 2004).

(3) able to effectively control for Type I error (Howell, 2004; Mertler & Vannatta, 2005). By using the ANOVA procedure I was able to generate a statistical comparison of all the factor score means in one procedure, instead of having to conduct the multiple procedures that would have been necessitated by the use of independent *t*-tests. Performing the multiple *t*-tests would have increased the chance of Type 1 error, which is falsely rejecting the null hypothesis when it is true (Howell, 2004; Mertler & Vannatta, 2005).

Addressing Assumptions for ANOVA. Before conducting comparisons using the ANOVA procedure I checked to see if the assumptions for the procedure had been met. The ANOVA procedure consists of a family of parametric, statistical procedures that is based on a number of assumptions. These assumptions must be met because they affect how the results from an ANOVA procedure are interpreted (Mertler & Vannatta, 2005). Therefore as a first step to analyzing data, researchers must evaluate how the assumptions are met before conducting statistical tests and analyzing the results (Howell, 2004; Mertler & Vannatta, 2005). The assumptions for ANOVA are adequacy of sample size, independence of observations, equal sample sizes, normality, and homogeneity of variance (Howell, 2004).

Adequacy of Sample Size. The adequacy of sample size assumption posits that the size of each group must be approximately equal on each dependent measure. The power of the statistical procedure could be diminished when sample sizes are disproportionately unequal (Stevens, 2009). I assessed this assumption by comparing the sample sizes across the each of the dependent variables. Results revealed that the sample sizes were not equal. Research is mixed regarding the impact of sample size on results from a one-way ANOVA. One group of researchers (Hair, Anderson, Tatum, & Black, 1995) has indicated that if the sample in each cell

exceeds the number of dependent variables then the presence of an unequal sample should have little impact on the results. The smallest group size for the racial grouping was nine and the number of dependent variables was eight; therefore this guideline was met. Another source has indicated that ANOVA is robust to moderate departures from this assumption (Howell, 2004). Yet other research has indicated that unequal sample sizes can affect the homogeneity of variance assumption in ANOVA procedures (Stevens, 2009). Because this research is exploratory in nature, and because of the varying guidelines on unequal sample size, I concluded that the unequal sample sizes should not have a large impact on the results.

Independent Scores. The independence of observation assumption states that scores in each sample must be independent and the scores in one group must not be repeated in the other group (Mertler & Vannatta, 2005). This assumption cannot be tested empirically; rather, it is judged as a feature of the data collection process. The participants in the study completed the measures at various times during the data collection process at various colleges from across the U.S. In addition, each participant could select only one option for the independent variables of race and gender. The aforementioned criterion rendered it unlikely that individual scores could be replicated across the two groups. Therefore, the scores on the dependent variables were assumed to be independent of each other.

Assumptions Associated with the T-Test

The following assumptions for the *t*-test were explored to determine the appropriateness of using the test to make the group comparisons:

Continuous Variables. The dependent variables were scores on the two items related to Overall Program Satisfaction. One item asked participants to indicate their overall level of satisfaction with the summer program. The second item asked participants to rate the likelihood

that they would recommend the program to others. Scores on each item could range from 1 to 5. Thus both variables were considered to be continuous variables for the purpose of this study.

Independence of Scores. The independence assumption states that scores in each sample must be independent and the scores for one group must not be repeated in the other group (Mertler & Vannatta, 2005). This assumption cannot be tested empirically; rather, it is judged as a feature of the data collection process. The study participants completed the measures at various times during the data collection process at various colleges across the U.S. The aforementioned criterion rendered it unlikely that individual scores could be replicated across the two groups. Therefore, the scores on the dependent variables were assumed to be independent of each other.

Validity of Formal and Informal Organizational Support Measures

Factor Analysis. Factor analysis was used to assess the construct validity of the Formal and Informal Organizational Support Scales. Its primary purpose is to determine if items on a survey or instrument measure a similar construct (Mertler & Vannatta, 2005). Results from the factor analysis were used to examine the degree to which the observed factors emerged as the hidden constructs among the items included the two surveys. A separate factor analysis was conducted for each scale. The prescreening phase for factor analysis pertained to addressing the methodological issues and testing the assumptions associated with it.

Methodological Issues of Factor Analysis. Four primary methodological issues were considered in reaching the decision to use EFA (Harris, 2013). Those issues were the appropriateness of subjecting the data to EFA procedures, the adequacy of the variables-to-factors ratio (*p:r*), the adequacy of the sample size, and the interpretation of the factors generated by the EFA (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Details regarding how each issue was addressed are presented in the paragraphs below.

Appropriateness of EFA. First, the issue of the appropriateness of subjecting the data to EFA was assessed by the Bartlett Test of Sphericity and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy. The Bartlett Test examines the magnitude of the correlations among variables in a data set, with the null hypothesis indicating that the variables are uncorrelated (Mertler & Vannatta, 2009). If the null hypothesis is rejected, then there would not be a need to conduct a factor analysis because the variables/items would not be correlated (Mertler & Vannatta, 2009). The Bartlett Test was used to "test the null hypothesis that the variables are not significantly correlated and should yield a statistically significant outcome before proceeding with the factor analysis" (Meyers, Gamst, & Guarino, 2013, p. 335).

Results from the Bartlett Test were X=1895.00 (*df* = 153, *N* = 207, *p* = .000) for the formal support and for the informal support X=30656.45 (*df* = 4000, *N* = 324, *p* = .000). These results indicated that the degree of correlations among variables on the formal and informal resources survey was adequate for performing EFA. The Kaiser-Meyer-Olkin (KMO) also measures the magnitude of correlations among a set of variables; it tests whether the correlations are small. The KMO measures the adequacy of the factor analysis, the value of which should be greater than 0.5 for a satisfactory factor analysis to proceed (Mertler & Vannatta, 2005). The KMO for the formal support was .90 and .94 for the informal support. Data from both indicated that the degree of intercorrelations among the items was suitable for subjecting the data to EFA (Ary et al., 1996). Results from KMO indicated that the degree of correlations among the variables of formal and informal support was adequate for performing EFA.

Adequacy of Number of Variables. The second methodological issue that I addressed was the adequacy of the number of variables-to-factors ratio (*p:r*) for the formal and informal survey questions. Data from previous research has shown that highly overdetermined factors

(those represented by three to five variables) produce the most stable factor patterns (Fabrigar et al., 1999; MacCallum, Widaman, Zhang, & Hong, 1999). Researchers also have recommended that *p:r* be at least 3:1 (Fabrigar et al., 1999; MacCallum et al., 1999). The minimum variables-to-factors ratio for formal resources was 6:1 (30 items to 5 scales) and 34:1 for informal resources (102 items to 3 scales). I therefore judged that the variables-to-factors ratio for the hypothesized scales exceeded conventional recommendations, and concluded that the number of variables was adequate for performing EFA procedures.

Adequacy of Sample Size. The third methodological issue regarded the adequacy of the sample size for conducting factor analysis. This determination was based on previous findings which cumulatively suggest a measure of flexibility in determining the number of participants required for conducting EFA (MacCallum et al., 1999). Tabachnik and Fidell (1996) recommended that at least 300 cases be used for factor analysis. A number of other researchers (MacCallum et al., 1999; Onwuegbuzie & Daniel, 2003; Stevens, 2009) have indicated that the number of cases must not be less than five cases per variable. The ratio of cases to variables for the formal organizational resources was 40 to 1 (207 participants/5 scales), which surpassed the recommended minimum ratios. The ratio of cases to variables for the informal organizational resources was 104 to 1 (324 participants/3 scales). In both cases the variables-to-factors ratio surpassed the recommended minimum ratios, and I judged the sample size to be adequate for proceeding with EFA.

Interpreting Factors. The fourth methodological consideration pertained to interpreting the factors generated by the EFA. Several rules have been established to guide interpretation and reduce subjectivity. A commonly used rule specifies that only variables with pattern/structure coefficients of .40 or higher on a factor should be considered (Kaplan & Saccuzzo, 2009). I used

Kaplan and Saccuzzo's rule to determine which factors to retain on the instrument. Results from the EFA procedures are presented in further detail in Chapter IV, which contains a separate discussion for results from the factor analysis for each of the formal and informal organizational resources.

Reliability of Formal and Informal Organizational Support Measures

A reliability analysis was used to explore the reliability of the formal and informal organizational support measures. This section addresses the details and results associated with the reliability analysis.

Reliability Analysis. A reliability analysis was conducted on the items assigned to formal and informal organizational factors based on the results from the factor analysis. I used a central approach to conducting the reliability analysis, using SPSS software to compute alpha coefficients and the confidence intervals for the empirically derived factors (Fan & Thompson, 2001). Cronbach's alpha was used to assess the reliability of data collected from the items included in the survey (Cohen & Cohen, 1983; Trochim & Donnelly, 2007). According to Westhuis and Thayer (1989), coefficient alpha is the best measure of internal consistency because it "provides a good estimate of the major source of measurement error, sets the upper limits of reliability, [and] provides the most stable estimate of reliability" (p. 157). The significance of the obtained alphas was tested against the value of .70 because past research suggests that values of .70 or greater indicate that a scale is internally consistent (Fan & Thompson, 2001; Kaplan & Saccuzzo, 2009; Mertler & Vannatta, 2005).

Assessing Predictive Relationships: The Use of Hierarchical Linear Regression

Hierarchical linear regression was used to explore the predictive relationships between the independent variables and the criterion variable. Hierarchical regression is a statistical

analysis that is predicated upon the following assumptions: adequacy of sample size, linearity, normality, homogeneity of variance or homoscedasticity, and absence of multicollinearity (Stevens, 2009). The first step of a regression analysis is to test the degree to which statistical assumptions have been met. Testing statistical assumptions associated with a statistical procedure enables researchers to interpret their findings more accurately and assess the degree to which errors may impact the interpretation of the results (Onwuegbuzie & Daniel, 2003). There are specific procedures for testing each assumption, which are discussed below.

Adequacy of Sample Size Assumption. The reliability of results obtained from a statistical procedure is partly a function of the sample size from which the results were obtained (Howell, 2004; Mertler & Vannatta, 2004; Stevens, 2009). There are minimum sample sizes needed for each statistical procedure. In general, the minimum sample size is affected by the following parameters: a) the level of desired precision for the statistical procedure (γ); b) the accepted confidence interval or accepted level of error (ϵ); and c) the value of the squared population multiple correlation (ρ^2) (Stevens, 2009). According to the table presented by Stevens (2009), using the parameters of $\gamma = .90$, $\epsilon = .05$, and $\rho^2 = .50$, the minimum sample size needed to generate a reliable regression equation for three to eight variables was approximately 124 participants. In addition, a general rule of thumb regarding sample size for a regression analysis is to have at least 10 to 15 cases for each predictor variable (Field, 2009; Stevens, 2009). These guidelines were used to assess the adequacy of the sample size. The data used in the regression analysis for this study contained results for 138 participants, an adequate sample size for achieving the desired level of power for the study, which was set at $\gamma = .80$ (Mertler & Vannatta, 2005; Stevens, 2009).

Linearity and Normality Assumptions. The linearity and normality assumptions can be assessed simultaneously by observing a visual depiction of the distribution of scores on a graph (Mertler & Vannatta, 2005). Two such graphs are the histogram and the Normal P-P Plot of the Regression Standardized Residuals. Both plots graphically compare the shape of a distribution of scores to the shape of the normal distribution (Stevens, 2009). The histogram generates a visual display of frequency distribution of a set of scores, revealing the shape of that distribution. A visual inspection of the graphs for each of the dependent variables (overall program satisfaction and STEM research career plans) revealed that the pattern of scores for the successful STEM outcome closely approximated the shape of the normal curve. The normality assumption also can be assessed by a visual scatter plot of the scores for the dependent variables. The scatter plot of the residuals should approximate the shape of a rectangle when the normality assumption is upheld. The graphs for each of the dependent variables revealed that the pattern of scores approximated a rectangular shape. A visual inspection of the histogram and scatter plot of the scores on the successful STEM outcomes showed that the normality assumption was upheld.

The P-P Plot provides visual information regarding linearity and normality by plotting the scores of a distribution against the normal curve. The shape of the normal distribution is represented by a 45^{o} straight line on a graph. When data for a variable is normally distributed, the data on the P-P Plot would approximate this line. When the linearity assumption is upheld, the spread of scores would cluster closely to the 45^{o} straight line. The assumptions were tested for linearity and normality for each dependent variable using the P-P Plot. The data points roughly approximated the shape of a straight line with some points falling above the line and some points falling below the line. It was concluded that the assumptions of normality and linearity were

upheld for both dependent variables (overall program satisfaction and STEM research career plans).

Homogeneity of Variance/Homoscedasticity Assumption. The homogeneity of variance assumption assumes equal variances across the scores for the continuous variables (Mertler & Vannatta, 2005). This assumption can be tested by examining bivariate scatter plots for the continuous variables of interest. The scatter plots will approximate an elliptical shape when the homoscedasticity assumption is upheld (Mertler & Vannatta, 2005). The graphs of the bivariate scatter plots showed that the scatter plots approximated the shape of an ellipse shape. It was concluded that the homoscedasticity assumption was upheld for the data set.

Multicollinearity Assumption. A major concern in regression analysis is multi-collinearity, which occurs when there is a high degree of correlation ($r \geq .80$) between the independent variables (Mertler & Vannatta, 2005). Multicollinearity in this study was assessed by examining the correlation matrix for the predictor variables and through the multicollinearity diagnostics produced by SPSS. Table 4.11 presents the results from the correlation analysis. Multicollinearity was also evaluated from the collinearity statistics produced from the regression function in SPSS. Results showed that in no case did the correlations exceed the criteria of ($r \geq .80$). The presence of multicollinearity is tested by the tolerance statistic and the variance inflation factor (VIF). The values for the tolerance statistic can range from .0 to 1, and values which exceed .20 indicate a lack of multicollinerity among the independent variables (Mertler & Vannatta, 2005). In the absence of multicollinearity the values for the VIF should be less than 10. The results from both analyses support the assumption that multicollinearity was not a problem for this data set.

REFERENCES

REFERENCES

Adams, J. H., Aubert, R. E., & Clark, V. R. (1998). The relationship among John Henryism, hostility, perceived stress, social support, and blood pressure in African-American college students. *Ethnicity & disease, 9*(3), 359-368.

Adedokun, O. A., Bessenbacher, A. B., Parker, L. C., Kirkham, L. L., & Burgess, W. D. (2013). Research skills and STEM undergraduate research students' aspirations for research careers: Mediating effects of research self-efficacy. *Journal of Research in Science Teaching*, *50*(8), 940-951.

Aguirre, A., Jr. (1993). *Summer research opportunity programs. Voices and visions of success in pursuit of the Ph.D. Enhancing the minority presence in graduate education v: Council of Graduate Schools.*

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179-211.

Ajzen, I. (2006). Constructing a TpB questionnaire: Conceptual and methodological considerations, Retrieved March 21, 2013, from http://people.umass.edu/aizen/tpb.html.

Ajzen, I., & Fishbein, M. (1973). Attitudinal and normative variables as predictors of specific behavior. *Journal of Personality and Social Psychology, 27*, 41- 57.

Ajzen, I., & Madden, T. J. (1986). Prediction of goal directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of Experimental Social Psychology, 22*, 453-474.

Alfred, L. J., Atkins, C., Lopez, M., Chavez, T., Avila, V., & Paolini, P. (2005). A science pipeline pathway for training underrepresented students in the biomedical sciences. *Journal of Women and Minorities in Science and Engineering, 11*, 45-60.

Allen, W. R. (1992). The color of success: African-American college student outcomes at predominantly white and historically black public colleges and universities. *Harvard Educational Review, 62*(1), 26-44.

Allen, W. R., Bonous-Hammarth, M., & Suh, S. A. (2004). Who Goes to College? High School Context, Academic Preparation, the College Choice Process, and College Attendance. In E. P. St. John (ed.), *Readings on Equal Education.* Vol. 20: *Improving Access and College Success for Diverse Students: Studies of the Gates Millennium Scholars Program.* New York: AMS Press.

Allen, V. L., & van de Vliert, E. (Eds.). (1984). *Role transitions: Explorations and explanation*s. New York: Plenum.

Allen, B. M., & Zepeda, Y. (2007). From baccalaureate to the professoriate: Cooperating to increase access to graduate education. *New Directions for Higher Education*, (138), 75–82.

Allen-Ramdial, S. A. A., & Campbell, A. G. (2014). Reimagining the Pipeline: Advancing STEM Diversity, Persistence, and Success. *BioScience*.

Altbach, P. G., & Peterson, P. M. (2008). Higher education as a projection of America's soft power. In Y. Watanabe & D. L. McConnell (Eds.), *Soft power superpowers: Cultural and national assets of Japan and the United States* (pp. 37-53). Armonk, NY: M. E. Sharpe.

American Speech-Language-Hearing Association (2011). Minority student recruitment, retention and career transition practices: A review of the literature. Retrieved from http://www.asha.org/practice/multicultural/recruit/litreview.htm.

Antonio, A. L. (2004). The influence of friendship groups on intellectual self-confidence and educational aspirations in college. *Journal of Higher Education, 75*(4), 446-471.

Armstrong, E., & Thompson, K. (2003). Strategies for increasing minorities in the sciences: A University of Maryland, College Park model. *Journal of Women and Minorities in Science and Engineering*, *9*(2), 159-167.

Ary, D., Jacobs, L. C., & Razavieh, A. (1996).*Introduction to research in education* (5th ed.). Fort Worth, TX: Harcourt Brace.

Asera, R. (2001, May). *Calculus and community: A history of the emerging scholars program*. Princeton, NJ: The College Board.

Astin, A. W. (1977). *Four critical years: Effects of college on beliefs, attitudes, and knowledge.* San Francisco: Jossey-Bass.

Astin, A. W. (1985). *Achieving educational excellence: A critical assessment of priorities and practices in higher education*. San Francisco: Jossey-Bass.

Astin, A. (1993). *What matters in college? Four critical years revisited*. San Francisco: Jossey Bass.

Attinasi, L. C. (1989). Getting in: Mexican Americans' perceptions of university attendance and the implications for freshman year persistence. *Journal of Higher Education, 60*, 247-277.

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

Baker, T. L., & Velez, W. (1996). Access to and opportunity in postsecondary education in the United States: a review. *Sociology of Education, 69*, 82-101.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of Social and Clinical Psychology, 4*(3), 359-373.

Barisa, M. T., & Holland, C. (1993, November). *The graduate achievement program: A description of the first year of a summer enrichment program in math and science for minority undergraduate students.* Paper presented to the Mid-South Educational Research Association, New Orleans, LA.

Barlow, A. E., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of research in science teaching, 41*(9), 861-881.

Barnett, R. C., & Baruch, G. K. (1985). Women's involvement in multiple roles and psychological distress. *Journal of Personality and Social Psychology, 49,* 135-145.

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,* 1173–1182.

Baron, S., Field, J., & Schuller, T. (Eds.). (2000). *Social capital: Critical perspectives*. New York: Oxford University Press.

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

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

Benn, E. K., Quarles, L., Sofianou, A., Perez, V., Nieto, V., & Boden-Albala, B. (2014). Abstract T MP64: John Henryism, Race-Ethnicity and Stroke Risk: Pilot Findings From the DESERVE Trial. *Stroke*, *45*(Suppl 1), ATMP64-ATMP64. http://stroke.ahajournals.org/content/45/Suppl_1/ATMP64.short

Ben-Porath, Y. (1980). The f-connection: Families, friends, and firms and the organization of exchange. *Population and Development Review, 6*(1), 1-30.

Berger, J. B. (2001). Understanding the organizational nature of student persistence: Empirically-based recommendations for practice. *Journal of College Student Retention, 3*(1), 3-21.

Bernhard, E. (1997). *Gender differences in role stress: Role ambiguity, conflict and overload during the college transition*. Unpublished dissertation, Northwestern University.

Berry, J. W., Poortinga, Y. H., Segall, M. H., & Dasen, P. R. (1992). *Cross-cultural psychology: Research and applications.* New York: Cambridge University Press.

Blake-Beard, S., Bayne, M. L., Crosby, F. J., & Muller, C. B. (2011). Matching by race and gender in mentoring relationships: Keeping our eyes on the prize. *Journal of Social Issues, 67*(3), 622-643.

Blanc, R. A., DeBuhr, L. E., & Martin, D. C. (1983). Breaking the attrition cycle: The effects of supplemental instruction on undergraduate performance and attrition. *Journal of Higher Education, 54*(1), 80-90.

Bolling, P., Novemsky, L., & Dios, R. (1988). Dealing with racial diversity in pre-college programs: Increasing interaction. In *Conference proceedings: Pre-college education of minorities in science and engineering* (pp. 235-237). Newark: New Jersey Institute of Technology Press.

Bonner, T. N. (1958). Sputniks and the educational crisis in America. *Journal of Higher Education, 29*(4), 177-184.

Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science, mathematics, and engineering majors. *Journal of Negro Education, 69*(1-2), 92-111.

Bonsangue, M. V., & Drew, D. E. (1995, Spring). Increasing minority students' success in calculus. *New Directions for Teaching and Learning, 61*, 23-33.

Bourdieu, P. (1977). *Outline of a Theory of Practice*. Cambridge: Cambridge University Press.

Bourdieu, P. (1986). The forms of capital. In J. Richardson (Ed.), *Handbook of Theory and Research for the Sociology of Education* (pp. 241-248). New York: Greenwood.

Bourdieu, P. (1996). *The state nobility*. Cambridge: Polity Press.

Bourdieu, P., & Wacquant, L. (1992). *An invitation to reflexive sociology.* Chicago: University of Chicago Press.

Bowen, W., & Bok, D. (1998). *The shape of the river*. Princeton, NJ : Princeton University Press.

Bowles, T. J., & Jones, J. (2003). An analysis of the effectiveness of supplemental instruction: The problem of selection bias and limited dependent variables. *Journal of College Student Retention, 5*(2), 235-243.

Bowman, P. J. (1977). *Motivational dynamics and achievement among urban community college students: A situationally-oriented path goal expectancy approach*. Unpublished doctoral dissertation, University of Michigan.

Bowman, P. J. (1983). Significant involvement and functional relevance: Challenge to survey research. *Social Work Research, 9*, 21-27.

Bowman, P. J. (1989). Research perspectives on Black man: Role strain and adaptation across the adult life cycle. In R. L. Jones (Ed.), *Black adult development and aging* (pp. 117–150). Berkeley, CA: Cobbs & Henry.

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

Bowman, P. J. (2011a). Toward a comprehensive strength-based assessment system: A social psychological approach. In P. J. Bowman & E. St. John (Eds.), *Diversity, merit, and higher education* (Readings on equal education, Vol. 25, pp. 161-186). NY: AMS.

Bowman, P. J. (2011b). Need for a 21st century merit agenda in higher education. In P. J. Bowman & E. St. John (Eds.), *Diversity, merit, and higher education* (Readings on equal education, Vol. 25, pp. 1-13). NY: AMS.

Bowman, P. J. (2013). A strengths-based social psychological approach to resiliency: Cultural diversity, ecological, and life span issues. In S. Prince-Embury & D. Saklofske (Eds.), *Resilience in Children, Adolescents, and Adults* (pp. 299-324). New York: Springer.

Bowman, P. J., & Howard, C. S. (1985). Race-related socialization, motivation and academic achievement: A study of Black youth in three generation families. *Journal of the American Academy of Child Psychiatry, 24*, 134–141.

Bowman, P. J., & St. John, E.P. (Eds.). (2011). *Readings on Equal Education*. Vol. 25. Diversity, Merit, and Higher Education: Toward a Comprehensive Agenda for the 21st Century. New York: AMS Press.

Boyd M. K., & Wesemann J. L., (Eds.). (2009). *Broadening Participation in Undergraduate Research: Fostering Excellence and Enhancing the Impact*. Washington, DC: Council on Undergraduate Research.

Boyer Commission on Educating Undergraduates in the Research University. (1998). Reinventing undergraduate education: A blueprint for America's research universities. Stony Brook, NY: The Carnegie Foundation for the Advancement of Teaching.

Braxton, J. M. (2000). Introduction: Reworking the student departure puzzle. In J. M. Braxton (Ed.), *Reworking the student departure puzzle.* Nashville, TN: Vanderbilt University Press.

Braxton, J., & Hirschy, A. (2005). Theoretical developments in study of college student departure. In A. Seidman (Ed.), *College student retention: Formula for student success.* Westport, CT: American Council of Education/Praeger.

Brislin, R. (1993). *Understanding culture's influence on behavior.* Orlando, FL: Harcourt Brace.

Broatch, L. (1989). Keeping minds in motion: The schooling of minority engineers. *College Board Review, 55*(153), 40-45.

Brown, S. W. (2002). Hispanic students majoring in science or engineering: What happened in their educational journeys?. *Journal of Women and Minorities in Science and Engineering, 8,* 123-148.

Brown III, M. C., & Davis, J. E. (2001). The historically Black college as social contract, social capital, and social equalizer. *Peabody Journal of Education, 76*(1), 31-49.

Building Engineering and Science Talent (BEST). (2004). A *bridge for all: Higher education design principles to broaden participation in science, technology, engineering and mathematics,* San Diego, CA: BEST.

Burke, D. L. (1996). Multi-year teacher/student relationships are a long-overdue arrangement. *Phi Delta Kappan, 77*(5), 360-361. EJ 516 053.

Bush, V. (1945). *Science, the endless frontier: A report to the president on a program for postwar scientific research*. Washington, DC: National Science Foundation.

Cabrera, A. F., Nora, A., & Castaneda, M. B. (1992). The role of finances in the persistence process: A structural model. *Research in Higher Education, 33*(5), 571-593.

Cameron, K. S. (1984). Organizational adaptation and higher education. *Journal of Higher Education, 55,* 122-144.

Cargile, S. D., & Woods, J. E. (1988). Strengthening black students' academic preparedness for higher education. *Journal of Black Studies, 19,* 150-162.

Carreathers, K. R., Beekman, L., Coatie, R. M., & Nelson, W. L. (1996). Three exemplary retention programs. *New Directions for Student Services, 74,* 35-53.

Carter, F. D., Mandell, M. B., & Maton, K. I. (2009). The Influence of On-Campus, Academic Year Undergraduate Research on STEM PhD Outcomes: Evidence from the Meyerhoff Scholarship Program. *Educational Evaluation and Policy Analysis, 31,* 441-462.

Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues, 67,* 469-491.

Chen, X. (2009). Students Who Study Science, Technology, Engineering, and Mathematics (STEM) in Postsecondary Education. Stats in Brief. NCES 2009-161. *National Center for Education Statistics*.

Chubin, D. E., & DePass, A. L. (2012). *Understanding interventions that broaden participation in research careers: Intervening to critical mass (Vol. V).* Understanding-Interventions.org

Chubin, D. E., DePass, A. L., & Blockus, L. (2009). *Understanding interventions that broaden participation in research careers: Embracing the breadth of purpose* (Vol. III). Washington, DC: American Association for the Advancement of Science.

Clark, R., & Adams, J. H. (2004). Moderating effects of perceived racism on John Henryism and blood pressure reactivity in Black female college students. *Annals of Behavioral Medicine, 28*(2), 126-131.

Clewell, B., & Campbell, P. B. (2002). Taking stock: Where we've been, where we are, where we're going. *Journal of Women and Minorities in Science and Engineering, 8*, 255-284.

Clewell, B.C., deCohen, C.C., Deterding, N., & Tsui, L. (2006). Final report on the evaluation of the National Science Foundation Louis Stokes Alliance for Minority Participation Program. Retrieved September 17, 2010, from http:///www.urban.org/url.cfm?id=411301

Clewell, B., & Fortenberry, N. (Eds.). (2009). *Framework for Evaluating Impacts of Broadening Participation Projects*.

Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlations analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum

Cohen, S., Gottlieb, B. H., & Underwood, L. G. (2000). Social relationships and health. In S. Cohen, L. G. Underwood, & B. H. Gottlieb (Eds.) *Social support measurement and intervention: A guide for health and social scientists* (pp. 3-25). New York: Oxford University Press.

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological bulletin, 98*(2), 310.

Cohoon, J. M., & Aspray, W. (2006). *Women and information technology: Research on underrepresentation.* MIT Press.

Cole, F. L. (1995). Implementation and evaluation of an undergraduate research practicum. *Journal of Professional Nursing, 11*(3), 154-160.

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.

Coleman, J. (1988). Social capital in the creation of human capital. *American Journal of Sociology, 94*, 95-120.

Coleman J. (1990). *Equality and achievement in education*. Westview Press, Boulder.

Coleman J. (1994). *Foundations of social theory.* Cambridge: Belknap Press of Harvard Univ. Press.

Committee on Equal Opportunities in Science and Engineering. (2004). *Broadening participation in America's science and engineering workforce: The 1994–2003 decennial and 2004 biennial reports to Congress*. Arlington, VA: National Science Foundation (CEOSE 04-01).

Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce (US), Committee on Science, Engineering, and Public Policy (US), & National Research Council (US). Policy and Global Affairs. (2010). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. National Academies Press.

Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development (CAWMSET). (2000). Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology. Arlington, VA: National Science Foundation.

Council of Graduate Schools (CGS). (1992). *Enhancing the Minority Presence in Graduate Education II: Assessing Progress*. Washington, DC: CGS.

Coverman, S. (1989). Role Overload, Role Conflict, and Stress: Addressing Consequences of Multiple Role Demands. *Social Forces, 67*, 965-982.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches.* London: Sage Publications.

Cunningham, B. K. (1984). *Religious orientation as a coping resource*. Unpublished Doctoral Dissertation, University of Michigan.

Davis, C. S. G., & Finelli, C. J. (2007). Diversity and retention in engineering. *New Directions for Teaching and Learning*, (111), 63-71.

Davis, D. J. (2006). *The summer research opportunity program: Mentorship and the socialization of underrepresented minorities into the professoriate.* Unpublished Doctoral Dissertation, University of Illinois, Urbana-Champaign.

Davis, D. J. (2007). Complexity and Chaos Theories as Metaphoric Lenses: An Alternative in Exploring the Voices of Marginalized Populations. *Essays in Education, 22*, 28-38.

Davis, D. J. (2008). Mentorship and the socialization of unrepresented minorities into the professoriate: Examining various influences. *Mentoring and Tutoring: Partnership in Learning, 16*(3), 278–293.

Davis J. D. (2010). The academic influence of mentoring upon African American undergraduate aspirants to the professoriate. *Urban Review, 42*, 143–158.

Davis, R. B. (1991). Social support networks and undergraduate student academic-success-related outcomes: A comparison of Black students on Black and White campuses. In W. R. Allen, E. G. Epps, & N. Z. Haniff (Eds.), *College in Black and White: African American students in predominantly White and in historically Black public universities* (pp. 143-157). Albany, NY: State University of New York Press.

DePass, A. L., & Chubin, D. E. (2008). *Understanding interventions that encourage minorities to pursue research careers: Building a community of research and practice*. Bethesda, MD: American Society of Cell Biology.

Dika, S. L., & Singh, K. (2002). Applications of social capital in educational literature: A critical synthesis. *Review of Educational Research, 72*, 31–60.

Douglass, J. A. (2000). A certain future: Sputnik, American higher education, and the survival of a nation. In R. D. Launius, J. M. Logsdon, & R. W. Smith (Eds.), *Reconsidering sputnik: Forty years since the Soviet satellite* (pp. 327-362). Amsterdam: Harwood.

Dowd, A. C., Malcom, L. E., & Bensimon, E. M. (2009). *Benchmarking the success of Latina and Latino students in STEM to achieve national graduation goals*. Center for Urban Education.

Duderstadt, J. J. (2007). *A roadmap to Michigan's future: Meeting the challenge of a global knowledge-driven economy.* Paper presented at the Educating a STEM Workforce New Strategies for U-M and the State of Michigan, Ann Arbor, MI.

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.

Ebreo, A. (1998). *Subjective culture, perceived social support, and adaptive coping: A multi-ethnic study of the transition to college*. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Ebreo, Fonseca-Bolorin, & Bowman (2011). Diversity and comprehensive strategies in higher education. In P. J. Bowman & E. St. John (Eds.), *Diversity, merit, and higher education* (Readings on equal education, Vol. 25, pp. 299-324). NY: AMS.

Eccles, J. S. (2011). Understanding educational and occupational choices. *Journal of Social Issues, 67*(3), 644 – 648

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109–132.

Eisenberger, R., & Stinglhamber, F. (2011). *Perceived organizational support: fostering enthusiastic and productive employees*. Washington: American Psychological Association Books.

Elgren, T., & Hensel, N. (2006). Undergraduate research experiences: Synergies between scholarship and teaching. P*eer Review, 8*(1), 4.

Elliott, R., Strenta, A. C., Adair, R., Matier, M., & Scott, J. (1996). The role of ethnicity in choosing and leaving science in highly selective institutions. *Research in Higher Education, 37*(6), 681-709.

Erickson, S. K. (2007). 'Can I get your email': Gender, networking and social capital in an undergraduate bioengineering classroom. *Journal of Women and Minorities in Science and Engineering, 13,* 175-189.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods, 4*(3), 272.

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

Falconer, J., & Holcomb, D. (2008). Understanding Undergraduate Research Experiences from the Student Perspective: A Phenomenological Study of a Summer Student Research Program. *College Student Journal*, *42*(3), 869-878.

Fan, X., & Thompson, B. (2001). Confidence intervals about score reliability coefficients, please: An *EPM* guidelines editorial. *Educational and Psychological Measurement, 61,* 517–531.

Farmer-Hinton, R. L., & Adams, T. L. (2006). Social capital and college preparation: Exploring the role of counselors in a college prep school for Black students. *Negro Educational Review, 57*(1/2), 101- 116.

Feather, N. T. (1982). Unemployment and its psychological correlates: A study of depressive symptoms, self-esteem, Protestant Ethic values, attributional style, and apathy. *Australian Journal of Psychology, 34,* 309-323.

Fechheimer, M., Webber, K., & Kleiber, P. B. (2011). How well do undergraduate research programs promote engagement and success of students?. *CBE-Life Sciences Education*, *10*(2), 156-163.

Feldman, D. C. (1999). Toxic mentors or toxic protégés? A critical re-examination of dysfunctional mentoring. *Human Resource Management Review*, *9*: 247-278.

Fernander, A. F., Duran, R. E., Saab, P. G., & Schneiderman, N. (2004). John Henry Active Coping, education, and blood pressure among urban blacks. *Journal of the National Medical Association, 96*(2), 246.

Field, J. (2003). *Social capital*. New York: Routledge.

Finney, N., & Simpson, L. (2009). Population dynamics: The roles of natural change and migration in producing the ethnic mosaic. *Journal of Ethnic and Migration Studies, 35* (9), 1479–1496.

Foertsch, J. A., Alexander, B. B., & Penberthy, D. L. (1997). *Evaluation of the U W-Madison's summer undergraduate research programs.* (Evaluation).

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

Folkman, S., & Lazarus, R. (1991). Coping and emotion. In A. Monet, & R. Lazarus (Eds.), *Stress and Coping. An Anthology* (pp. 207-227). Columbia University Press: New York.

Fournier, V., & Kelemen, M. (2001). The crafting of community: Recoupling discourses of management and womanhood. *Gender, Work and Organizations, 8*(3), 267-290.

Frehill, L. M., DeFazio, S. M., & Hill, S. T. (2008). *Confronting the "new" American dilemma – Underrepresented minorities in engineering: A data-based look at diversity*. Retrieved from the National Action Council for Minorities in Engineering website: http://www.nacme.org/user/docs/NACME%2008%20ResearchReport.pdf

Friedman, D.L., & Kay, N.W. (1990). Keeping what we've got: A study of minority student retention in engineering. *Engineering Education, 80*(3), 407-412.

Fries-Britt, S. (2000). Identity Development of High-Ability Black Collegians. *New directions for teaching and learning, 2000*(82), 55-65.

Fullilove, R. E., & Treisman, P.U. (1990). Mathematics achievement among African American Undergraduates at the University of California, Berkeley: An evaluation of the mathematics workshop program. *Journal of Negro Education, 59*(3), 463-478.

Gaffney, N. A. (Ed.). (1993). *Enhancing the minority presence in graduate education: Catalyst for success: The summer research opportunity program.* Washington, DC; Council of Graduate Schools.

Gandara, P., & Maxwell-Jolly, J. (1999). *Priming the Pump: Strategies for Increasing the Achievement of Underrepresented Minority Undergraduates*. New York: The College Board.

Gansemer-Topf, A. M., & Schuh (2003). Instruction and academic support expenditures: An investment in retention and graduation. *Journal of College Student Retention, 5*(2), 135-145.

George, Y. S., Neale, D. S., Van Horne, V. V., & Malcolm, S. M. (2001). In pursuit of a diverse science, technology, engineering and mathematics workforce. Retrieved from American Association for the Advancement of Science website: http://ehrweb.aaas.org/mge/Reports/Report1/AGEP/AGEP_report.pdf.

Gilbert, L. A. (1985). Dimensions of same-gender student-faculty role-model relationships. *Sex Roles, 12*(1-2), 111-123.

Girves, J. E., Zepeda, Y., & Gwathmey, J. K. (2005). Mentoring in a Post-Affirmative Action World. *Journal of Social Issues, 61*(3), 449-479.

Gloria, A. M., Castellanos, J., Lopez, A., & Rosales, R. (2005). An examination of academic nonpersistence decisions of Latino undergraduates. *Hispanic Journal of Behavioral Sciences, 27*, 202-223.

Goastellec, G. (2008). Globalization and implementation of an equity norm in higher education: Admission processes and funding framework under scrutiny, *Peabody Journal of Education, 83*(1), 71-85.

Gonzalez, N., Moll, L., & Amanti, C. (2005). *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. Mahwah, NJ: Erlbaum.

Good, J. M., Halpin, G., & Halpin, G. (2000). A promising prospect for minority retention: Students becoming peer mentors. *Journal of Negro Education, 69*, 375–383.

Good, J., Halpin, G., & Halpin, G. (2002). Retaining black students in engineering: Do minority programs have a longitudinal impact? *Journal of College Student Retention: Research, Theory & Practice, 3*(4), 351-364.

Goode, W. J. (1960). A theory of role strain. *American Sociological Review, 25*(4), 483-496.

Goodman, P. S., (2002). *Technology enhanced learning: Opportunities for change.* Mahwah, NJ: L. Erlbaum.

Goyette, K. A., & Mullen, A. L. (2006). Who studies the arts and science? Social background and the choice and consequences of undergraduate field of study. *Journal of Higher Education, 77*(3), 488-538.

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

Granovetter, M. (1973). The strength of weak ties. *American Journal of Sociology, 78*,1360-1380. Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology, 91*, 481-510.

Gutiérrez, K. (2006). *Culture matters: Rethinking educational equity*. New York, NY: Carnegie Foundation.

Hair Jr, J. F., Anderson, R. E., Tatham, R. L., & William, C. Black. 1995. *Multivariate data analysis, 4*.

Halpern, D. (2005). *Social capital*. Malden, MA: Polity Press.

Hamilton, S.F., Hamilton, M.A., Hirsch, B.J., Hughes, J., King, J. & Maton, K. (2006). Community contexts for mentoring. *Journal of Community Psychology 34*(6) 727-746.

Harris, S. M. (2002). Student perceptions of the mentoring relationship in higher education. In F. K. Kochan (Ed.), *The organizational and human dimensions of successful mentoring programs and relationship* (pp. 53-68). Greenwich, CT: Information Age Publishing.

Harris, S. M. (2013). Development of the perceptions of mentoring relationships survey: A mixed methods approach. *International Journal of Multiple Research Approaches, 7*(1), 83-95.

Hartman, H., & Hartman, M. (2005). Undergraduate women's participation in professional organizations. *Journal of Women and Minorities in Science and Engineering, 11*, 117-137.

Hathaway, R., Nagda, B., & Gregerman, S. (2002). The relationship of undergraduate research participation to graduate and professional educational pursuit: An empirical study. *Journal of College Student Development, 43*, 614–631.

Hathaway, R. S., Sharp, S., & Davis, C-S. (2001). Programmatic efforts affect retention of women in science and engineering. *Journal of Women and Minorities in Science and Engineering, 7*, 107-124.

Hernandez, J. (2000). Understanding the retention of Latino college students. *Journal of College Student Development, 41*, 575-588.

Hernandez, J. C., & Lopez, M. A. (2004). Leaking pipeline: Issues impacting Latino/a college student retention. *Journal of College Student Retention, 6*, 37-60.

Herndon, M. K., & Hirt, J. B. (2004). Black Students and their Families What Leads to Success in College. *Journal of Black Studies, 34*(4), 489-513.

Herreros, F. (2004). *The problem of forming social capital: Why trust?*. New York, NY: Palgrave Macmillan.

Hill, R. B. (1999). *Strengths of African American families: 25 years later*. New York, NY: R&B Press.

Home, A. (1998). Predicting role conflict, overload and contagion in adult women university students with families and jobs. *Adult Education Quarterly, 48*, 85-98.

House, J. S. (1974). Occupational Stress and Coronary Heart Disease: A Review and Theoretical Integration. *Journal of Health and Social Behavior, 15*, 12-27.

House, J. S., Umberson, D, & Landis, K. (1988). Structures and processes of social support. *Annual Review of Sociology, 14*, 293-318.

Hrabowski, III, F. A., & Maton, K. I. (1995). Enhancing the success of African-American students in the sciences: Freshmen year outcomes. *School Science and Mathematics, 95*, 18–27.

Hrabowski III, F. A., & Maton, K. I. (2009). Change institutional culture, and you change who goes into science. *Academe, 95*(3), 11-15.

Hrabowski III, F. A., Maton, K. I., Greene, M. L., & Greif, G. L. (2002). *Overcoming the odds: Raising academically successful African-American young women*. New York: Oxford University Press.

Hrabowski III, F. A., Maton, K. I., & Greif, G. L. (1998). *Beating the odds: Raising academically successful African-American males*. New York: Oxford University Press.

Hsieh, H. F., Zimmerman, M. A., Xue, Y., Bauermeister, J. A., Caldwell, C. H., Wang, Z., & Hou, Y. (2014). Stress, active coping, and problem behaviors among Chinese adolescents. *American Journal of Orthopsychiatry*, *84*(4), 364.

Hu, S., Kuh, G. D., & Gayles, J. G. (2007). Engaging undergraduate students in research activities: Are research universities doing a better job?. *Innovative Higher Education*, *32*(3), 167-177.

Huang, G., Taddese, N., & Walter, E. (2000). *Entry and persistence of women and minorities in college science and engineering education* (NCES Rep. No. 2000-601). Washington, DC: U.S. Government Printing Office.

Hunter, A. B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education, 91*(1), 36-74.

Hurley, M., Jacobs, G., & Gilbert, M. (2006, Summer). The basic SI model. *New Directions for Teaching and Learning, 106,* 11-22.

Hurtado, S., Cabrera, N. L., Lin, M. H., Arellano, L., & Espinosa, L. L. (2009). Diversifying science: Underrepresented student experiences in structured research programs. *Research in Higher Education, 50*(2), 189-214.

Hurtado, S., Eagan, M. K., Tran, M. C., Newman, C. B., Chang, M. J., & Velasco, P. (2011). "We do science here": Underrepresented students' interactions with faculty in different college contexts. *Journal of Social Issues, 67*(3), 553-579.

Hurtado, S., Han, J. C., Sáenz, V. B., Espinosa, L. L., Cabrera, N. L., & Cerna, O. S. (2007). Predicting transition and adjustment to college: Biomedical and behavioral science aspirants' and minority students' first year of college. *Research in Higher Education, 48*(7), 841-887.

Ingersoll, R. (1996). *Out-of-field teaching and educational equality.* Washington, DC: National Center for Education Statistics.

Ingersoll, R. (1999). The problem of underqualified teachers in American secondary schools. *Educational Researcher, 28*(2), 26-37.

Ishitani, T. T., & DesJardins, S. L. (2002). A longitudinal investigation of dropout from college in the United States. *Journal of College Student Retention, 4*(2), 173-201.

Jacobi, M. (1991). Mentoring and undergraduate academic success: A literature review. *Review of Educational Research, 61*(4), pp. 505-532.

Jackson, L. A., Gardner, P. D., & Sullivan, L. A. (1993). Engineering persistence: Past, present, and future factors and gender differences. *Higher Education, 26,* 227-246.

Jackson, J. S., Tucker, M. B., & Bowman, P. J. (1982). Conceptual and methodological problems in survey research on black Americans. In W. T. Liu (Ed.), *Methodological Problems in Minority Research*. Chicago, IL: Pacific/Asian American Mental Health Research Center.

James, S. A. (1993). The narrative of John Henry Martin. *Southern Cultures, 1*(1), 83-106.

James, S. A., Hartnett, S. A., & Kalsbeek, W. D. (1983). John Henryism and blood pressure differences among black men. *Journal of Behavioral Medicine, 6*(3), 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*(3), 259-275.

Jamieson, D. W., & Thomas, K. W. (1974). Power and conflict in the student-teacher relationship. *The Journal of Applied Behavioral Science, 10*(3), 321-336.

Jennings, M., & Clarke, G. (Eds.). (2008). *Development, Civil Society and Faith-Based Organisations: Bridging the Sacred and the Secular*. Basingstoke: Palgrave Macmillan.

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

Johnson, K. J. (2005). *The effects of formal and informal socialization on students' plans related to graduate school, career, and life course.* Unpublished doctoral dissertation, University of Minnesota.

Johnson, A. (2007). Graduating underrepresented African American, Latino, and American Indian students in science. *Journal of Women and Minorities in Science and Engineering, 13*, 1-21.

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

Judd, C. M., Smith, E. R., & Kidder, L. H. (1991). *Research methods in social relations*. Fort Worth: Holt, Rinehart, and Winston.

Junge, B., Quiñones, C., Kakietek, J., Teodorescu, D., & Marsteller, P. (2010). Promoting undergraduate interest, preparedness, and professional pursuit in the sciences: an outcomes evaluation of the SURE program at Emory University. *CBE-Life Sciences Education*, *9*(2), 119-132.

Kahn, R. L., & Byosiere, P. (1992). Stress in organizations. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of industrial and organizational psychology, Vol. 3* (2nd ed., pp. 571-650). Palo Alto, CA: Consulting Psychologists Press.

Kahn, R. L., Wolfe, D. M., Quinn, R. P., Snoek, J. D., & Rosenthal, R. A. (1964). *Organizational stress: Studies in role conflict and ambiguity*. New York: Wiley.

Kahveci, A., Southerland, S. A., & Gilmer, P. J. (2008). From marginality to legitimate peripherality: Understanding the essential functions of a women's program. *Science Education, 92*(1), 33–64.

Kaplan, H. B. (1996). *Psychosocial stress from the perspective of self-theory.* New York: Academic Press.

Kaplan, R. M., & Saccuzzo, D. P. (2009). *Psychological testing: Principles, applications, and issues* (6th ed.). Belmont, CA: Wadsworth-Thompson.

Kardash, C. M. (2000). Evaluation of undergraduate research experience: Perceptions of undergraduate interns and their faculty mentors. *Journal of Educational Psychology, 92*(1), 191.

Katz, D., & Kahn, R. L. (1978). *The social psychology of organizations* (2nd ed.). New York: Wiley.

Kelloway, E.K., & Barling, J. (1990). Item content versus item wording: Disentangling role conflict and role ambiguity. *Journal of Applied Psychology, 75*, 738-742.

Kendricks, K. D., & Arment, A. R. Adopting A K-12 Family Model With Undergraduate Research To Enhance STEM. *Educational Review*, *62*, 26-44.

Kerr, C. (1964). *The uses of the university*. Cambridge, MA: Harvard University Press.

King, L. A., & King, D. W. (1990). Role conflict and role ambiguity: A critical assessment of construct validity. *Psychological Bulletin, 107,* 48–64.

Kuh, G. D. (2008). Excerpt from *"High-Impact Educational Practices: What They Are, Who Has Access to Them, and Why They Matter".* Association of American Colleges and Universities.

Kuh, G., Schuh, J., Whitt, E., & Associates. (1991). *Involving colleges.* San Francisco: Jossey-Bass.

Kulik, C. C., Kulik, J. A., & Schwalb, B. A. (1983). College programs for high risk and disadvantaged students: A meta-analysis of findings. *Review of Educational Research, 53*(3), 397-414.

Landis, R. B. (1985). *Handbook on Improving the Retention and Graduation of Minorities in Engineering*. New York: The National Action Council for Minorities in Engineering.

Landis, R. B. (1988). The Case for Minority Engineering Programs, *Engineering Education, 78*, 756–761.

Landis, R. B. (1995). *Studying engineering: A road map to a rewarding career*. Los Angeles: Discovery Press.

Lee, C. (2003). Guest Editor. Reconceptualizing race and ethnicity in educational research, *Educational Researcher, 32*(5), 3-5.

Lee, R. M. (2003). Do ethnic identity and other-group orientation protect against discrimination for Asian Americans? *Journal of Counseling Psychology, 50*(2), 133–141. doi.:10.1037/0022-0167.50.2.133.

Lee, R. M. (2005). Resilience against discrimination: Ethnic identity and other-group orientation as protective factors for Korean Americans. *Journal of Counseling Psychology, 52*(1), 36–44. doi:10.1037/0022-0167.52.1.36.

Leicht-Scholten, C., Weheliye, A., & Wolffram, A., 2009. Institutionalisation of gender and diversity management in engineering education. *European Journal of Engineering Education*, 34 (5), 447.

Lent, R. W., Brown, S. D., Sheu, H. B., Schmidt, J., Brenner, B. R, Gloster, C. S., Wilkins, G., Schmidt, L. C., Lyons, H., & Treistman, D. (2005). Social cognitive predictors of academic interests and goals in Engineering: Utility for women and students at historically black universities. *Journal of Counseling Psychology, 52*(1), 84-92.

Lentz Jr, F. E., Allen, S. J., & Ehrhardt, K. E. (1996). The conceptual elements of strong interventions in school settings. *School Psychology Quarterly, 11*(2), 118.

Leslie, L. L., McClure, G., & Oaxaca, R. L. (1998). Women and minorities in science and engineering: A life sequence analysis. *Journal of Higher Education, 69*, 239-276.

Lewis, B. F. (2003). A critique of literature on the underrepresentation of African Americans in science: Directions for future research. *Journal of Women and Minorities in Science and Engineering, 9*, 361–373.

Lewis, J. L., Menzies, H., Najera, E. I., & Page, R. N. (2009). Rethinking trends in minority participation in the sciences. *Science Education, 93*, 961–977.

Lichtenstein, M. (2005). The importance of classroom environments in the assessment of learning community outcomes. *Journal of College Student Development, 46*(4), 341-356.

Lifton, D., Cohen, A., & Schlesinger, W. (2007). Utilizing first-year curricula linkage to improve in-major persistence to graduation: results from a four-year longitudinal study. *Journal of College Student Retention: Research, Theory &Practice*, *9*(1), 113-125.

Lin, N. (1999). Social networks and status attainment. *Annual Review of Sociology, 25*, 467-487.

Lin, N. (2000). *Social capital: A theory of structure and action*. Cambridge: Cambridge University Press.

Lin, N. (2008). A network theory of social capital. *The handbook of social capital*, 50-69.

Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): first findings. *Cell biology education*, *3*(4), 270-277.

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

Lopez, J. D. (2005). Race-related stress and sociocultural orientation among Latino students during their transition into a predominately White, highly selective institution. *Journal of Hispanic Higher Education*, *4*(4), 354-365.

Loury, G. C. (1977). A dynamic theory of racial income differences. In P. A. Wallace & A. M. LaMonde (Eds.), *Women, minorities and employment discrimination* (pp. 153-186). Lexington, MA: Lexington Books.

Loury, G. C. (1987). Why should we care about group inequality? *Social Philosophy & Policy*, *5*, 249-271.

Lynch, S. (1998). Whose science for which Americans? Worldview and science education reform. *Educational Horizons, 37*, 132-139.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological methods*, *4*(1), 84.

Maldonado, D. E. Z., Rhoads, R., & Buenavista, T. L. (2005). The student-initiated retention project: Theoretical contributions and the role of self-empowerment. *American Educational Research Journal*, *42*(4), 605-638.

Malcom, S. M., Van Horne, V. V., Gaddy, C. D., & George, Y. S. (1998). *Losing Ground: Science and Engineering Graduate Education of Black and Hispanic Americans*. American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005.

Mallinckrodt, B., & Leong, F. T. (1992). International graduate students, stress, and social support. *Journal of College Student Development*.

Malone, K. R., & Barabino, G. (2009). Narrations of race in STEM research settings: identity formation and its discontents. *Science Education, 93*, 485–510.

Mamaril, N. J., & Royal, K. D. (2008). Women and minorities in engineering: A review of the literature. *Online Submission*.

Marable, T. D. (1999). The role of student mentors in a pre-college engineering program. *Peabody Journal of Education, 74*, 44–54.

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

Maton, K. I., Hrabowski, F. A., & Ozdemir, M. (2007). Opening an African American STEM Program to talented students of all races: evaluation of the Meyerhoff Scholars Program, 1991–2005. *Charting the future of college affirmative action: Legal victories, continuing attacks, and new research, 2007*, 125-156.

Maton, K. I., Hrabowski, F. A., III., & 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., Weise, T.V.M., & Hrabowski, F.A. III. (2012). The Meyerhoff Scholars Program: A strengths-based, institution-wide approach to increasing diversity in STEM. *Mt. Sinai Journal of Medicine, 79*, 610-623.

Maton, K. I., Sto. Domingo, M. R., Stolle-McAllister, K., Zimmerman, J. L., Hrabowski, III, F. A. (2009). Enhancing the number of African Americans who pursue STEM Ph.D.s: Meyerhoff Scholarship Program outcomes, processes, and individual predictors. *Journal of Women and Minorities in Science and Engineering, 15*, 15–37.

Matyas, M. L., & Dix, L. S. (1992). *Science and engineering programs: On target for women?* Washington, DC: National Academy Press.

Matyas, M. L., & Malcolm, S. (191). Investing in human potential: Science and engineering at the crossroads. Washington, DC: American Association for the Advancement of Science.

May, G. S., & Chubin, D. E. (2003). A retrospective on undergraduate engineering success for underrepresented minority students. *Journal of Engineering Education, 92*, 27-39.

Mayo, J. R., Murguia, E., & Padilla, R. V. (1995). Social integration and academic performance among minority university students. *Journal of College Student Development, 36*, 542–552.

McAdams, D. P., Reynolds, J., Lewis, M., Patten, A. H., & Bowman, P. J. (2001). When bad things turn good and good things turn bad: Sequences of redemption and contamination in life narrative and their relation to psychosocial adaptation in midlife adults and in students. *Personality and Social Psychology Bulletin, 27,* 474–485.

McDonough, P. M. (1997). *Choosing colleges: How social class and schools structure opportunity.* Albany: State University of New York Press.

McGuire, S. Y. (2006, Summer). The impact of supplemental instruction on teaching students how to learn. *New Directions for Teaching and Learning, 106*, 3-10.

McJamerson, E. M. (1992). Undergraduate academic major and minority student persistence: Individual choices, national consequences. *Equity & Excellence, 25*(2), 35-48.

McNeil, J. D. (1998). *Racial and ethnic socialization among college students: A multi-ethnic family ecology approach*. Unpublished doctoral dissertation, Northwestern University.

McShea, B., & Yarnevich, M. (1999). The effects of a summer mathematics enrichment program on Hispanic mathematical achievement. *Journal of Women and Minorities in Science and Engineering, 5*(2).

Members of the 2005 "Rising Above the Gathering Storm" Committee. (2010). *Rising above the gathering storm, revisited: Rapidly approaching category 5*. Washington, DC: National Academies Press.

Merkel, C. A. (2001). *Undergraduate research at six research universities: A pilot study for Association of American Universities*. Pasadena, Washington, DC: Association of American Universities.

Merkel, C. (2003). Undergraduate research at the research universities. *New Directions for Teaching and Learning, 2003*(93), 39-54.

Merritt, M. M., Bennett, G. G., Williams, R. B., Sollers, J. J., & Thayer, J. F. (2004). Low educational attainment, John Henryism, and cardiovascular reactivity to and recovery from personally relevant stress. *Psychosomatic Medicine, 66*(1), 49-55.

Mertler, C. A. & Vannatta, R. A. (2005). *Advanced and multivariate statistical methods: Practical application and interpretation* (3rd ed.). Los Angeles: Pyrczak.

Merton, R. K. 1957. *Social Theory and Social Structure*. Glencoe, Ill.: Free Press.

Meyers, L. S., Gamst, G. C., & Guarino, A. J. (2013). *Performing data analysis using IBM SPSS*. John Wiley & Sons.

Meznek, J., McGrath, P., & Garcia, F. (1989). *The Puente Project. A report to the Board of Governors, California Community Colleges.* Sacramento: Office of the Chancellor. (ERIC Document Reproduction Service No. ED 307 920)

Millspaugh, J. J., & Millenbah, K. F. (2004). Value and structure of research experiences for undergraduate wildlife students. *Wildlife Society Bulletin, 32*(4), 1185-1194.

Moore III, J. L. (2005). Underachievement among gifted students of color: Implications for educators. *Theory Into Practice, 44*(2), 167-177.

Moore, J. L., Madison-Colmore, O., & Smith, D. M. (2003). The prove-them-wrong syndrome: Voices from unheard African-American males in engineering disciplines. *The Journal of Men's Studies, 12*(1), 61-73.

Moreno, S. E., Muller, C., Asera, R., Wyatt, L., & Epperson, J. (1999). Supporting minority mathematics achievement: The Emerging Scholars Program at the University of Texas at Austin. *Journal of Women and Minorities in Science and Engineering, 5*(1), 53-66.

Morrison, C., & Williams, L. E. (1993). Minority engineering programs: A case for institutional support. *NACME Research Letter (NACME), 4*(1), 10.

Moses, Y. T. (1989). *Black women in academe: Issues and strategies.* Washington, DC: Association of American Colleges. (ERIC Document Reproduction Service No. ED 311 817)

Mullings, L. (2002), The sojourner syndrome: Race, class, and gender in health and illness. *Voices, 6*, 32–36. doi: 10.1525/vo.2002.6.1.32.

Murphy, T., Stafford, K., & McCreary, P. (1998). Subsequent course and degree paths of students in Treisman-style workshop calculus program, *Journal of Women and Minorities in Science and Engineering, 4*, 381-396.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads. National Academies Press; Washington, DC: 2011.

National Science Board. (2000). *Science and engineering indicators 2000 (NSB-00-1)*.Arlington, VA: National Science Foundation. National Science Foundation. (2000). *Women, minorities and persons with disabilities in science and engineering - 2000*. Retrieved June 6, 2007, from http://www.nsf.gov/statistics/nsf00327/

Neville, H. A., Heppner, P. P., & Wang, L. F. (1997). Relationship among racial identity attitudes, perceived stressors, and coping styles for African American college students. *Journal of Counseling and Development, 75*, 303-11.

Nivet, M. A. (2010). Minorities in academic medicine: Review of the literature. *Journal of vascular surgery, 51*(4), S53-S58.

Nocera, D. G., Harrison, J. F., Reed, D. A., & Roberts, C. H. (1996). Enhanced performance in chemistry by minorities at the university level: A comprehensive program. *Journal of Chemical Education, 73*, 1131-1137.

Oestereichen, M. (1987). Effectiveness of peer tutors/mentors for disadvantaged students at Brooklyn College: Preliminary analyses. *Linkages, 5*, 27-33. (ERIC Document Reproduction Service No. ED 296 021)

Office of Research of Women's Health for the NIH Working Group on Women in Biomedical Careers. (2008). National Institutes of Health (NIH) Career Development and Mentoring Programs. Retrieved from http://womeninscience.nih.gov/pdf/NIHPrograms.pdf.

Olson, S., & Fagen, A. P. (Eds.). (2007). *Understanding interventions that encourage minorities to pursue research careers: summary of a workshop*. National Academies Press.

Onwuegbuzie, A. J., & Daniel, L. G. (2003). Typology of analytical and interpretational errors in quantitative and qualitative educational research. *Current Issues in Education*,*6*(2), 1-29.

Orellana, M. F., & Bowman, P. (2003). Cultural diversity research on learning and development: Conceptual, methodological, and strategic considerations. *Educational Researcher,32*(5), 26-32.

Painter, S. L., Bailey, R., Gilbert, M., & Prior, J. (2006, Summer). New directions for supplemental instruction. *New Directions for Teaching and Learning, 106*, 73-84.

Parsons, T. (1951) *The Social System.* Glencoe, IL: Free Press.

Pascarella, E., & Terenzini, P. (1991). *How college affects students: Findings and insights from twenty years of research.* San Francisco: Jossey-Bass.

Patton, L. D., Morelon, C., Whitehead, D. M., & Hossler, D. (2006). Campus-based retention initiatives: Does the emperor have clothes? In E. P. St. John & M. Wilkerson (Eds.), *Reframing persistence research to improve academic success* (pp. 9-24). New Directions for Institutional Research, No. 130. San Francisco: Jossey-Bass.

Pearlin, L. I. (1983). Role strains and personal stress. In H. B. Kaplan (Ed.), *Psychosocial Stress: Trends in Theory and Research* (pp. 3-32). New York: Academic Press.

Pearlin, L. I. (1989). The sociological study of stress. *Journal of Health and Social Behavior, 30*(3), 241-256.

Pearlin, L. I., & Schooler, C. (1978). The structure of coping. *Journal of health and social behavior*, 2-21.

Pender, M., Marcotte, D. M., Sto. Domingo, M. R., & Maton, K. I. (2010). The STEM pipeline: The role of summer research experience in minority students' graduate aspirations Ph.D. aspirations. *Education Policy Analysis Archives, 18*, 1-34.

Perna, L. W. (2005). The benefits of higher education: Sex, racial/ethnic, and socioeconomic group differences. *The Review of Higher Education, 29*(1), 23-52.

Perna, L., Lundy-Wagner, V., Drezner, N. D., Gasman, M., Yoon, S., Bose, E., & Gary, S. (2009). The contribution of HBCUs to the preparation of African American women for STEM careers: A case study. *Research in Higher Education, 50*(1), 1-23.

Peterson, M. W. (2007). The study of colleges and universities as organizations. In P.J. Gumport (Ed.), *Sociology of higher education: Contributions and their contexts* (pp. 147–186). Baltimore: The Johns Hopkins University Press.

Phinney, J. S., Campos, T., Cidhinnia, M., Padilla Kallemeyn, D. M., & Kim, C. (2011).Processes and outcomes of a mentoring program for Latino college freshmen. *Journal of Social Issues, 67*(3), 599–621.

Portes A. (1998). Social capital: its origins and applications in modern sociology. *Annual Review of Sociology, 22*, 1–24.

Portes, A. (2000). The two meanings of social capital. *Sociological Forum, 15*(1), 1–12.

Pounds, A. W. (1987). Black students' needs on predominantly white campuses. In D. J. Wright (Ed.), *Responding to the needs of today's minority students. New directions for student services: No. 38* (pp. 23-38). San Francisco: Jossey-Bass.

Prince-Embury, S., & Saklofske, D. H. (2013). *Resilience in children, adolescents, and adults: Translating research into practice*. New York: Springer.

Pritchard, M.E., Wilson, G.S., & Yamnitz, B. (2007). What predicts adjustment among college students: A longitudinal panel study. *Journal of American College* Health, *56*(1), 15-21.

Putnam, R. D. (1993). The prosperous community. *The American Prospect, 4*(13), 35-42.

Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. New York: Simon and Schuster.

Ragins, B. R., & Cotton, J. L. (1999). Mentor functions and outcomes: A comparison of men and women in formal and informal mentoring relationships. *Journal of Applied Psychology, 84*, 529-550.

Ragins, B. R., & McFarlin, D. B. (1990). Perceptions of mentor roles in cross-gender mentoring relationships. *Journal of Vocational Behavior, 37*, 321-339.

Ramos, C. (2011). ACT's P-16 partnerships: Expanding opportunity for academic merit. In P.J. Bowman & E. P. St. John (Eds.), *Diversity, merit, and higher education* (Readings on Equal Education, Vol. 25, Chapter 1). New York: AMS Press.

Randall, D. C., Wilbur, F. H., & Burkholder, T. J. (2004). Two models for an effective undergraduate experience in physiology and other natural sciences. *Advances in Physiology Education, 28*(1-4), 68-72.

Reichert, M., & Absher, M. (1997). Taking another look at educating African American engineers: The importance of retention. *Journal of Engineering Education, 86*(3), 241-253.

Reichert, W. (2006). A success story. Recruiting and retaining underrepresented minority doctoral students in biomedical engineering. *Liberal Education*, *92*(3), 52-55.

Rendón, L. I. (1994). Validating culturally diverse students: Toward a new model of learning and student development. *Innovative Higher Education, 19*(1), 33-51.

Rendón, L. I., Jalomo, R. E., & Nora, A. (2000). Theoretical considerations in the study of minority student retention in higher education. In J. M. Braxton (Ed.), *Reworking the student departure puzzle.* Nashville, TN: Vanderbilt University Press.

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

Rich, B. L. (2007). Job engagement: Construct validation and relationships with job satisfaction, job involvement, and intrinsic motivation. *Dissertation Abstracts International Section A: Humanities and Social Sciences, 67*, 30-66.

Richman, L. S., vanDellen, M., & Wood, W. (2011). How Women Cope: Being a Numerical Minority in a Male-Dominated Profession. *Journal of Social Issues, 67*(3), 492-509.

Rizzo, J. R., House, R. J., & Lirtzman, S. I. (1970). Role conflict and ambiguity in complex organizations. *Administrative science quarterly*, 150-163.

Robbins, S. B., Lauver, K., Langley, R., Le, H., & Davis, D. (2004). Do psychosocial and study skill factors predict college outcomes? A meta-analysis. *Psychological Bulletin, 130*(2), 261-288.

Robinson, L. (2009). Students' Use of Group Mathematics Tutoring and Its Impact on Major Choice. In E. P. St. John (Ed.), *Readings on equal education, vol. 24*. New York: AMS Press, Inc.

Rowe, M. P. (1989). What actually works? The one-to-one approach. In C. S. Pearson, D. L. Shavlik, & J. G. Touchton (Eds.), *Educating the majority: Women challenge tradition in higher education* (pp. 375-383). New York: American Council on Education and Macmillan.

Rowley, L. & Bowman, P .J. (2009). Risk, protection, and achievement disparities among African American males: Cross-generation theory, research and comprehensive intervention. *Journal of Negro Education, 78*(3), 305–320.

Russell, M. L., & Atwater, M. M. (2005). Traveling the road to success: A discourse on persistence throughout the science pipeline with African American students at a predominantly white institution. *Journal of Research in Science Teaching, 42*(6), 691-715.

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

Russomanno, D., Best, R., Ivey, S., Haddock, J., Franceschetti, D., & Hairston, R. (2010). MemphiSTEP: A STEM talent expansion program at the University of Memphis. *Journal of STEM Education, 11*(1), 25-37.

Saldaina, D. H. (1994). Acculturative stress: Minority status and distress. *Hispanic Journal of Behavioral Sciences, 16*(2), 116-128.

Sanders, R. T. (1997). *Intellectual and psychosocial predictors of success in the college transition: A multi-ethnic study of freshmen students on a predominantly White campus*. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Schuller, T., Baron, S., & Field, J. (2000). Social capital: a review and critique. In S. Baron, J. Field, & T. Schuller (Eds.), *Social capital: critical perspectives* (pp. 1-38). Oxford: Oxford University Press.

Sedlacek, W. E. (2004). Why we should use noncognitive variables with graduate and professional students. *The Advisor: The Journal of the National Association of Advisors for the Health Professions, 24*(2), 32-39.

Seidman, I. (1998). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*. New York: Teachers' College Press.

Settles, I. H., Cortina, L. M., Stewart, A. J., & Malley, J. (2007). Voice matters: Buffering the impact of a negative climate for women in science. *Psychology of Women Quarterly, 31*(3), 270-281.

Seymour, E. (2001). Tracking the process of change in US undergraduate education in science, mathematics, engineering, and technology. *Science Education, 86,* 79-105.

Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences.* Boulder, CO: Westview Press.

Seymour, E., Hunter, A.-B., Laursen, S. L., & DeAntoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Science Education, 88*(4), 493 – 534.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston: Houghton Mifflin.

Sharp, L., Kleiner, B., & Frechtling, J. (2000). *A description and analysis of best practice finds of programs promoting participation of underrepresented undergraduate students in science, mathematics, engineering, and technology fields*. Washington, DC: WESTAT

Shay, J. (2000). The College Preparation Process. *Access Denied: Race, Ethnicity, and the Scientific Enterprise*, 187.

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

Shultz, E. L., Colton, G. M, & Colton, C. (2001). The adventor program: Advisement and mentoring for students of color in higher education. *Journal of Humanistic Counseling, Education and Development, 40*(2), 208-218.

Simpson, J. C. (2001). Segregated by subject: Racial differences in the factors influencing academic major between European Americans, Asian Americans, and African, Hispanic, and Native Americans. *The Journal of Higher Education, 72*(1), 63-100.

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*, 434-452.

Sondgeroth, M. S., & Stough, L. M. (1992). *Factors influencing the persistence of ethnic minority students enrolled in a college engineering program* (Report No. HE-026-184). San Francisco, CA: American Education Research Association. (ERIC Document Reproduction Service No. ED 353 923)

Sonnert, G. (2002). *Ivory bridges: Connecting science and society*. Cambridge, MA: The MIT Press.

St. John, E. P. (1991). The effects of student financial aid on persistence: A sequential analysis. *Review of Higher Education, 13*(3), 383-406.

St. John, E. P. (2003a). Keeping the promise: The impact of Indiana's twenty-first century scholars program. *Review of Higher Education, 17*(1), 103-123.

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

St. John, E. P., & Hossler, D. (1998). Higher education desegregation in the post-*Fordice* legal environment: A critical-empirical perspective. In R. Fossey, (Ed.), *Readings on Equal Education: Vol. 15, Race, the courts, and equal education: The limits of the law* (pp.123-156). New York: AMS Press.

St. John, E. P., Hu, S., & Fisher, A. F. (2011). *Breaking through the access barrier: Academic capital formation informing policy in higher education*. New York: Routledge. Educational Evaluation and Policy Analysis.

St. John, E. P., Hu, S., Simmons, A., Carter, D. F., & Weber, J. (2004). What difference does a major make? The influence of college major field on persistence by African American and White students. *Research in Higher Education, 45*(3), 209–232.

St. John, E. P., Kirshstein, R. J., & Noell, J. (1991). The effects of student financial aid persistence: A sequential analysis. *Review of Higher Education, 14*(3), 383-406.

St. John, E. P. (2008). Financial inequality and academic success: Rethinking the foundations of research on college students. W. Trent & E. P. St. John (Eds.), *Resources, assets, and strengths among successful diverse students: Understanding the contributions of the Gates Millennium Scholars Program. Readings on Equal Education, 23*.

Stanton-Salazar, R.D. (1997, Spring). A social capital framework for understanding the socialization of racial minority children and youths. *Harvard Educational Review*, *67*(1), 1-40.

Strayhorn, T. L. (2010). When race and gender collide: Social and cultural capital's influence on the academic achievement of African American and Latino males. *The Review of Higher Education, 33*(3), 307-332.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American psychologist, 52*(6), 613.

Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). New York, NY: Routledge.

Stewart, J. M. (1990). Mentoring by all means: A supporting rhetoric. In A. D. Johnson & P. Mroczek (Eds.), *Mentoring minorities and women: A challenge for higher education* (pp. 24-27). De Kalb: Northern Illinois University Press.

Stout, M. L., & McDaniel, A. J. (2006, Summer). Benefits to supplemental instruction leaders. *New Directions for Teaching and Learning, 106*, 55-72.

Stolle-McAllister, K., Sto. Domingo, M. R. S., & Carrillo, A. (2011). The Meyerhoff way: How the Meyerhoff scholarship program helps black students succeed in the sciences. *Journal of science education and technology, 20*(1), 5-16.

Strayhorn, T. L., & Saddler, T. N. (2009). Gender differences in the influence of faculty–student mentoring relationships on satisfaction with college among African Americans. *Journal of African American Studies, 13*(4), 476-493.

Strenta, C., Elliott, R., Russell, A., Matier, M., & Scott, J. (1994). Choosing and leaving science in highly selective institutions. *Research in Higher Education, 35,* 513-537.

Strauss, A. & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory.* London: Sage Publications.

Swail, W. S., & Holmes, D. (2000). Minority Student Persistence: A Model for Colleges and Universities. In S. T. Gregory (Ed.), *Academic Achievement of Minority Students: Perspectives, Practices, and Prescriptions*. Latham, MD: University Press of America.

Tabachnik, B. G., & Fidell, L. S. (1996). *Using multivariate statistics* (3rd. ed.). New York, NY: HarperCollins College Publishers.

Talbert, B. A., Larke, Jr., A., & Jones, W. A. (1999). Using a student organization to increase participation and success of minorities in agricultural disciplines. *Peabody Journal of Education, 74*(2), 90-104.

Taylor, R.J., Chatters, L.M., & Levin J. (2004*). Religion in the Lives of African Americans: Social, Psychological and Health Perspectives.* Thousand Oaks*: Sage Press.*

Terrion, J. L. (2006). Building social capital in vulnerable family's success markers of a school-based intervention program. *Youth & Society, 38*, 155-176.

Thelin, J. R. (2004). *A history of American higher education*. Baltimore: The Johns Hopkins University Press.

Thiry, H., & Laursen, S. L. (2011). The role of student-advisor interactions in apprenticing undergraduate researchers into a scientific community of practice. *Journal of Science Education and Technology*, *20*(6), 771-784.

Thiry, H., Laursen, S. L., & Hunter, A. B. (2011). What experiences help students become scientists?: A comparative study of research and other sources of personal and professional gains for STEM undergraduates. *The Journal of Higher Education, 82*(4), 357-388.

Thomas, G. E. (1985). College major and career inequality: Implications for Black students. *Journal of Negro Education, 54*(4), 537–547.

Thomas, G. E. (1992). Participation and degree attainment of African American and Latino students in graduate education relative to other racial and ethnic groups: An update from Office of Civil Rights data. *Harvard Educational Review, 62*(1), 45-65.

Thomas, L. L., Cancel, N. R., & Creed, M. (2007). Noncognitive Variables in College Admissions: The Case of the Noncognitive Questionnaire. *Educational and Psychological Measurement,* 67(4), 635–657.

Thompson, C. J., McNeill, J. A., Sherwood, G. D., & Starck, P. L. (2001). Using collaborative research to facilitate student learning. *Western Journal of Nursing Research, 23*(5), 504-516.

Tierney, W. G. (1992). An anthropological analysis of student participation in college. *Journal of Higher Education, 63*(6), 603-618.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Education Research, 45,* 89-125.

Tinto, V. (1987). *Leaving college: Rethinking the causes and cures of student attrition*. Chicago: The University of Chicago Press.

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.).Chicago: The University of Chicago Press.

Tonso, K. L. (1998, April). *Engineering gender-gendering engineering: What about women in nerd Dom?* Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA.

Torres, J. B., & Solberg, V. S. (2001). Role of self-efficacy, stress, social integration, and family support in Latino college student persistence and health. *Journal of Vocational Behavior, 59*(1), 53-63.

Tracy, L., & Johnson, T. W. (1981). What do the role conflict and role ambiguity scales measure?. *Journal of Applied Psychology, 66*(4), 464.

Trent, W. T. (1984). Equity consideration in higher education: Race and sex differences in degree attainment and major field from 1976 through 1981. *American Journal of Education, 92*(3), 280-305.

Trent, W., & Gong, Y. (2006). Achieving Justice and Equality in US Higher Education: An Exemplary Program to Increase the Participation of Underrepresented Students of Color. *Advances in Education in Diverse Communities: Research, Policy and Praxis, 5*, 387-420.

Trent, W. & St. John, E. P. (Ed.). (2008). Resources, assets, and strengths among successful diverse students; Understanding the contributions of the Gates Millennium Scholars Program. *Readings on equal education*, Vol. 23. New York: AMS Press, Inc.

Triantis, H., Lambert, W., Berry, J., Loner, W., Heron, A., Brisling, R., & Dragons, J.(Eds.). (1980-1981). *Handbook of cross-cultural psychology*, Vols. 1-6. Boston, MA: Allyn & Bacon.

Trochim, W., & Donnelly, J. P. (2007). *The research methods knowledge base* (3rd ed.). Mason, OH: Thomson.

Tsui, L. (2007). Effective strategies to increase diversity in STEM fields: A review of the research literature. *The Journal of Negro Education*, 555-581.

Tyson, W., Lee, R., Borman, K. M., Hanson, M.A. (2007). Science, technology, engineering, and mathematics (STEM) pathways: High school science and mathematics coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk, 12*(3), 243-270.

U. S. Congress. (1994). Goals 2000: Educate America Act. (ERIC Document Reproduction Service No. ED 361 834)

U. S. Government Accountability Office (GAO). (2005). *Higher education: Science, technology, engineering, and mathematics related trends* (GAO-06-114). Washington, DC: Ashby, C.

U. S. Government Accountability Office (GAO). (2006). *Higher education: Science, technology, engineering, and mathematics trends and the role of federal programs* (GAO-06-702T). Washington, DC: Ashby, C.

Vance, M. L. (1993). *A study of perceptual changes on the part of students with respect to their decisions to pursue graduate studies.* Unpublished doctoral dissertation, Michigan State University.

Vaux, A., Riedel, S., & Stewart, D. (1987). Modes of social support: The social support behaviors (SS-B) scale. *American Journal of Community Psychology*, *15*(2), 209-232.

Villarejo, M., & Barlow, A. E. L. (2007). Evolution and evaluation of a biology enrichment program for minorities. *Journal of Women and Minorities in Science and Engineering, 13*(2), 119–144.

Wardlow, G. W., Graham, D. L., & Scott, F. L. (1995). Barriers to professional careers as perceived by minority professionals in agriculture. *Proceedings of the Twenty-Second Annual National Agricultural Educational Education Research Meeting, 22*, 497-506.

Webb, J. (1969). *Space age management: The large scale approach*. New York: McGraw-Hill.

Weidman, J. C. (1984). Impacts of campus experiences and parental socialization on undergraduates' career choices. *Research in Higher Education*, *20*(4), 445-476.

Weinstein, N. D. (1998). Accuracy of smokers' risk perceptions. *Annals of Behavioral Medicine, 20*, 135-140. (Reprinted in Nicotine & Tobacco Research, 1999, 1, S123-130.)

Westhuis, D., & Thayer, B. A. (1989). Development and validation of the clinical anxiety scale: A rapid assessment instrument for empirical practice. *Educational and Psychological Research, 49*, 153–163.

White, M. A., Blaisdell, S., & Anderson-Rowland, M. (1998, November). Recruiting women into engineering graduate programs. In *Frontiers in Education Conference, 1998. FIE'98. 28th Annual* (Vol. 1, pp. 216-219). IEEE.

White, R. W. (1974). Strategies of adaptation: An attempt at systematic description. *Coping and adaptation*, *47*, 68.

White, J. L., Altschuld, J. W., & Lee, Y-F. (2008). Evaluating minority retention programs: Problems encountered and lessons learned from the Ohio Science and Engineering Alliance. *Evaluation and Program Planning. 31*(3), 277-283.

Williams, K. L. (2014). *Financial impediments, academic challenges and pipeline intervention efficacy: A role strain and adaptation approach to successful STEM outcomes for underrepresented students*, Unpublished doctoral dissertation, University of Michigan.

Winkleby, M. A., Ned, J., Ahn, D., Koehler, A., & Kennedy, J. D. (2009). Increasing diversity in science and health professions: A 21-year longitudinal study documenting college and career. *Journal of Science Education and Technology*, 1–11.

Woodcock, A., Hernandez, P., Estrada, M., & Schultz, P. W. (2012). The consequences of chronic stereotype threat: Domain identification and attrition. *Journal of Personality and Social Psychology, 103*, 635-646. doi: 10.1037/a0029120

Woolcock, M. (2001). The place of social capital in understanding social and economic outcomes. *Isuma: Canadian Journal of Policy Research, 2*(1), 1-17.

Wyer, M. (2003). Intending to stay: Images of scientists, attitudes toward women, and gender as influences on persistence among science and engineering majors. *Journal of Women and Minorities in Science and Engineering, 9,* 1-16.

Yeaton, W. H., & Sechrest, L. (1981). Critical dimensions in the choice and maintenance of successful treatments: strength, integrity, and effectiveness. *Journal of Consulting and Clinical Psychology, 49*(2), 156.

Yim, J. 2009. "'Being an Asian American male is really hard actually': A cultural psychology of Asian American masculinities and psychological well-being." (Doctoral dissertation), Department of Psychology and Women's Studies, the University of Michigan. Ann Arbor, MI, USA.

Zepeda, Y. (2010). Changing Classrooms, Changing Climate. In H. Neville, J. Chapa, and M. Browne-Huntt (Eds.), *Implementing Diversity: Contemporary Challenges and Best Practices at Predominately White Universities* (pp. 101-123). Urbana, IL: Center for Democracy in a Multicultural Society.

Zepeda, Y., & Farber, C. (2010). CIC SROP Program Evaluation. Retrieved from http://www.cic.net/docs/default-source/reports/sroppgmevalreportapr10.pdf?sfvrsn=0 .

Zhang, L. (2008). The way to wealth and the way to leisure: The impact of college education on graduates' earnings and hours of work. *Research of Higher Education, 49,* 199-213.

Zumbo, B. D., & Zimmerman, D. W. (1993). Is the selection of statistical methods governed by level of measurement? *Canadian Psychology/Psychologie Canadienne, 34*(4), 390.