Developing and Testing a Model to Predict Underrepresented Students' Plans for Graduate Study: Analysis of the 1988-2006 Cohorts of a Summer Research Program

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Abstract

The percentage of graduate degrees awarded to African American, Hispanic, and Native American students, as a group, remains low. Undergraduate research programs are one strategy currently implemented to increase underrepresented students' participation in graduate education. Results of several research and evaluation studies indicate that the programs are effective in enhancing participants' perceptions of and interests in graduate study, but there is a lack of understanding concerning how or why the programs are effective.

The current study employed structural equation modeling techniques to develop and test a model to investigate the relationships among program outcomes and underrepresented students' plans to pursue graduate study. Data for the study were taken from surveys administered to students in the 1988-2006 cohorts of one summer research program, resulting in a sample of just over 600 students. Results indicated that the model had good fit to the data with the initial data set, χ^2 (14, N= 319) = 17.47, p = .23, CFI = 1.00, TLI =1.00, RMSEA = .03, and SRMR = .04 and with the cross-validation data set, χ^2 (15, N= 317) = 19.78, p = .18, CFI = 1.0, TLI= 1.0, RMSEA= .03 and SRMR= .04. More specifically, in the cross-validation procedure, seven of the eight paths tested were significant at $p < .05$, indicating support for the hypothesized relationships among faculty preceptor relationship, program satisfaction, increased knowledge of graduate school and research, outcome value of program participation, increased interest in graduate school, and plans for graduate study. The amount of variance explained by the model was, 24% in sample one and 22% in sample two. The findings have implications for program design, program replication, program improvement, and evaluation.

DEDICATION

This dissertation is dedicated to the elders of the Lewis and Dandridge families and to my mom, dad, and sister. To the elders, I say thank you for being role models of strength, love, persistence, and success. To my immediate family, I say thank you for your continuous support and encouragement.

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CHAPTER 1
INTRODUCTION

Educational attainment promotes positive outcomes for individuals and for society. On the individual level, postsecondary degree attainment is associated with increased opportunity for upward mobility, primarily through the economic and social benefits it affords (Carter, 2001; Kazia, Varga, and Hoffman, 2004). Moreover, the rewards of postsecondary degree attainment are not limited to individual benefits, they also contribute to positive societal outcomes. The more educated the U.S. citizenry, the greater the contributions people can make to the workforce and to the country's effort to remain competitive in an increasingly global and information driven economy. Bandura (1997) captured this sentiment in stating:

> " Increasing complexities in technologies, social systems, and the international economy present different realities demanding new types of competencies…Societies pay dearly for the educational neglect of their youth…The net result is a decline in the quality, and standard of living."

Thus, the more formal education one obtains, the greater their personal resources are to develop as an individual and to contribute to society (Bandura, 1997). While postsecondary education is most commonly associated with undergraduate education, graduate study incorporates all of the aforementioned returns and extends them to a higher level. Stolzenberg (1994, p. 1044) asserted "Postbaccalaureate schooling profoundly affects access to some of the most powerful, prestigious, and remunerative positions in the occupational distribution (Kingston & Clawson, 1985), and graduate and professional schools are critical links in the chain of institutions that transmit and codify the most complex information in

modern industrial societies (Bourdieu 1977, 1984; Parsons 1964, p. 342 cited in Stolzenberg, 1994)." His statement demonstrates the important ways that graduate degree attainment broadens career opportunities and points to the intellectual capital and knowledge that are associated with graduate degree attainment. To some extent, the value of graduate education is reflected in part by the increase in the number of degrees awarded each year. During the 37 year period from 1960-1997 the number of bachelor degrees awarded in the United States tripled while the number of graduate degrees awarded quadrupled (Goyette, Mullen, & Soares, 2003). Similarly, NCES (2005) reported that between 1985 and 2004 graduate enrollment increased by approximately 57%. Additionally, between 1992-1993 and 2002-2003 the number of master's degrees awarded increased by 33% while the number of doctorates increased by 3% (NCES, 2004). Thus, there is a clear indication that graduate degree enrollment is experiencing an upward trend.

Despite the benefits conveyed by a graduate degree, certain segments of the population remain disproportionately absent from graduate programs. Specifically, African Americans, Hispanic Americans, and Native Americans, attend graduate school at rates far below their representation in the U.S. population. Each year since at least 1977, the percentage of doctoral degrees received by members of all the underrepresented groups combined was less than the percentage of doctoral degrees earned by nonresident aliens. For example, in 1976-1977, the National Center for Education Statistics (NCES, 2004) reported that nonresident aliens earned 11.3% of all doctorates compared to just 5.7% for all combined underrepresented groups (African Americans 3.8%, Hispanic Americans 1.6%, and Native Americans .3%). More recently, in 2004-2005 underrepresented students earned 7.2% (African Americans 3.9%, Hispanic Americans 3.0%, and Native Americans .3%) of

the 43,354 doctorates awarded (National Opinion Research Center [NORC], 2006). Thus, it is clear that students from certain ethnic groups have historically had low participation rates in graduate study and that the disparity continues today. The chasm in graduate degree attainment has negative and profound affects on members of underrepresented populations and on society as a whole. In terms of career development, educational attainment can restrict or expand the career opportunities for which individuals qualify, facilitating access to jobs that require specialized knowledge, and limiting or denying access to higher paying and higher status jobs (Pascarella, Wolniak, Pierson, & Flowers, 2004). Additionally, the paucity of underrepresented students receiving graduate degrees decreases the pool of individuals from underrepresented populations who are qualified to serve as college and university faculty (Walters, 1997). Unfortunately, fewer faculty of color also contributes to the lack of same race mentors for underrepresented students and the lack of diverse views and experiences in academia. Similarly, Leeman, Goeppinger, Funk, and Roland (2003) asserted that the absence of diversity in the research environment creates a void in the perspectives and experiences brought to research. Finally, unequal participation contributes to economic disparity and decreased social mobility for large numbers of individuals for whom graduate education could have improved their economic and social status.

Institutions of higher education (IHEs), government agencies, and various professional organizations acknowledge the dire consequences of racial/ethnic disparities in graduate study as well as the need to address unequal participation (Malcolm, Chubin, & Jesse, 2004; Government Accountability Office (GAO), 2006). One such effort that has been successful in promoting underrepresented students' participation in graduate study is the implementation of graduate school preparation programs (GSPPs). GSPP is a term used by

Simpson (2003) to describe interventions that are designed to increase ethnic minority students' preparation for and participation in graduate study. While the initiatives vary in structure and content, they share the same general mission: to acclimatize participants to conducting research and to prepare students to pursue and complete graduate studies. Research and evaluation studies have documented, in varying degrees, the programs' success. However, calls for additional research and evidence of the programs' effectiveness continue to resonate. Agencies that fund the initiatives are particularly interested in data showing that the project objectives are being met (NSF, 2000) and that resources are allocated to maximize results (GAO, 2006). The problem is compounded by the fact that the renewed emphasis on accountability coincides with what Mervis (2006) deemed a "data deficit," wherein some programs lack sufficient data to report outcomes and face challenges collecting data and tracking former students. Contrarily, individuals who work with the programs tend to be more aware of their impact, but encounter difficulty finding appropriate ways to demonstrate their accomplishments. In referring to the work of one federally funded national initiative, Grimmett, Bliss, Davis, & Ray (1998) asserted that the program's effectiveness in increasing participants' graduate school matriculation rates has chronically been "underanalyzed and underreported." Thus indicating that important outcomes can potentially, and perhaps are likely to, go undocumented. Thus, the aforementioned concerns point to two specific problems pertaining to research on GSPPs: 1) the need for quantifiable data linking outcomes to program experiences and 2) the need for strategies that help programs articulate or model their success.

Purpose of Study

The purpose of this exploratory study was to investigate the effects among select GSPP program outcomes and to test the salience of those outcomes in predicting undergraduate students' plans for graduate study. The study used data from the University of North Carolina at Chapel Hill's Summer Research Pre-Graduate Research Experience (SPGRE) program, which has been relatively successful in achieving its goals of reinforcing and promoting participants' interest in graduate study. According to Frierson (2006), of the more than 600 students who have completed SPGRE by 2004, approximately 70% have enrolled in graduate study. Of the students who completed SPGRE between 1988 -1998, 27% (94) have received master's degrees, 16% (57) have entered but not yet completed doctoral programs, and 28% (100) have earned doctorates. While previous research related to GSPPs reports positive outcomes such as the SPGRE statistics cited and students' positive perceptions of the research experiences in the programs, little is known about how various program components relate to each other (Eatman, 2001; Foertsch, Alexander, & Penberthy, 1997) or their relationship to participants' educational plans to pursue a graduate degree. Moreover, few studies have empirically examined the associations by which program participation might be linked to plans to pursue graduate study. One exception that was identified, Eatman (2001) examined the influence of GSPP factors along with variables such as educational experiences and family background. The current study seeks to understand the process by which graduate degree plans are developed or maintained through examination of participants' perception of selected program experiences. These program outcomes are represented visually, in a model depicting their relationship to one another, and are tested for goodness of fit in reproducing the data. Given that the study's sample consisted of students who have expressed an interest in graduate study and who were considered competitive

candidates for graduate school admission, the study focuses on the social-cognitive outcomes associated with participation in the GSPP program, rather than academic and background characteristics, which typically characterize inquiry in this field.

Background Program Information

The Summer Pre-Graduate Research Experience (SPGRE) Program is a summer research program designed to provide students from underrepresented ethnic populations with an in-depth meaningful research experience and to promote and reinforce interest in graduate study and research careers. The program is university-based and is hosted at a large Research Extensive institution in the southeast region of the country. SPGRE has run continuously since its inception in 1988 and has served more than 700 students. Recruitment is conducted on the national level, targeting students at colleges and universities across the country. Over the last 10 years, 45-60 students participate in the program each year. Students are pre-screened based on grade point average (GPA), letters of recommendation from faculty, academic classification, and their statement of interest. The mean GPA of accepted students has been 3.5 over the years. Faculty preceptors who work with the program review applications of students who pass the initial screening and select students with whom they would like to work during the summer. The selections tend to be based on mutual research interest and students' academic background. The research projects cover a broad range of disciplines, including the physical and natural sciences, social sciences, and the humanities. Students are expected to conduct research on a full-time basis for the ten-week program period. Moreover, participants reside in on-campus housing, which is provided at no cost, and support includes a stipend and food allowance. At the end of the program,

students are expected to produce a research paper related to their project and to present their research at a program poster session.

A variety of professional development, academic, and social activities are offered to students. Included among them are a weekly seminar series where guest speakers address topics such as writing a personal statement for graduate school admissions, identifying funding sources for graduate study, and developing an effective research poster for presentation. Additionally, students participate in a GRE preparation course, and engage in social activities such as cook-outs with graduate students and faculty mentors.

There are several benefits of using the SPGRE population for the current study. Primarily, educational plans (EPs) for a graduate degree are most informed at the collegiate level, once students have experienced college and are able to make better judgments about their ability and desire to continue on to graduate study. Secondly, although the population consists of students who have expressed an interest in learning more about graduate study and whose academic credentials make them strong candidates for graduate admission, at the end of the program not all students report plans to attend graduate school. Therefore, the study may inform our understanding of how the program outcomes differ among students who have EPs to pursue graduate study compared to those who do not.

Significance of Study

The study seeks to address voids in two research areas. First, in terms of GSPPs, the study contributes to a nascent body of literature that 1) applies model testing and 2) that contributes to theory building in GSPP research. This extends the methodological rigor beyond descriptive statistics and adds another perspective to augment the more frequent qualitative nature of GSPP research. Secondly, it responds to the call for more accountability

(Kardash, 2000) by assessing the effectiveness of this type of educational intervention in facilitating participants' development or maintenance of plans to pursue a graduate degree, and more importantly, it seeks to contribute to our understanding of the program processes associated with participants' plans to pursue graduate degrees. Using data that spans a 19-year time period from 1988-2006, the study analyzes and documents program outcomes and degree plans of almost 700 program participants. This is significant because it allows for analysis of data collected over a considerable time-period and of data pertaining to a large number and wide range of participants. Additionally, this work has significance for policy implications and program improvement, as well as the portability of the program to other sites. Moreover, the findings may be helpful to program administrators and funders in making decisions regarding the allocation of resources and program planning and implementation. Although data from this study pertain to one particular program, similar initiatives should find the knowledge generated applicable to improve the design and operation of their programs (Grimmett, Bliss, Davis, & Ray; 1998).

In addition to its contributions to the GSPP literature, this study has implications for career development literature, specifically as it relates to educational aspirations. Much of the research related to predicting EPs is based on models that were developed from samples that lacked ethnic diversity (Flores, 2006; Hill, 2005). This may be problematic because the models tend to have poor fit when applied to ethnically diverse students (Carter, 2001; Hamrick & Stage, 2004; Kerka, 2003). Pascarella, Wolniak, Pierson, and Flowers (2004) posit that while model specification and testing to explain and predict EPs have seen "substantial advances" in the last 20 years, insufficient attention has been directed to the variation among predictors of EPs as a factor of race. After finding gender and race/ethnicity

based differences in model fit for predicting high school students' educational and occupational aspirations, Mau & Bikos (2000) also suggest the creation and testing of models that incorporate "key variables" based on gender and ethnicity. This study will inform the literature by using a sample of more than 95% ethnic minority students, presenting a perspective that goes beyond the traditional singular demographic focus of the field and allowing for inclusion of variables hypothesized to be particularly relevant to the experiences of underrepresented students.

While the overarching goal of GSPPs is to increase graduate degree attainment rates for ethnically underrepresented students, it is also critical to measure intermediate outcomes because of the time lag between program participation and graduate degree attainment (NSF, 2000). In the current context, outcomes can be assessed in three major areas: 1) completion of a graduate program 2) matriculation into a graduate program and 3) educational plans to pursue a graduate degree. Educational plans (EPs) have been shown to be highly correlated with graduate school enrollment (Carter, 2001) and are cited as strong predictors of eventual degree attainment (Mau & Bikos, 2000; Pascarella, Wolniak, Pierson, & Flowers, 2004; Pascarella & Terenzini, 1991). In the context of GSPPs, EPs are significant because they are one of the most immediate program outcomes that can be determined at the conclusion of a program. Additionally, they are important because they represent the value students place on a graduate degree, are a product of students' educational experiences (Carter, 2001), and reflect their belief in their ability to matriculate into a graduate program. Finally, EPs typically represent goals which are important from a motivational perspective. Goals provide an accomplishment to work towards, thereby requiring individuals to make choices and engage in behaviors consistent with goal pursuit.

CHAPTER 2
Review of Literature

This chapter provides a review and critique of research on GSPPs (Graduate School Preparation Programs). The chapter is organized in the following sections: 1) an overview of the programs that prevail in the literature; 2) a discussion of literature related to GSPP alumni's graduate school matriculation rates and plans to attend graduate school; 3) a summary of outcomes related to participants' perceptions and satisfaction with various program components; and 4) the types of studies that have been conducted, by examining the conceptual frameworks employed, the types of analyses used, and the research questions investigated.

An exhaustive review of the literature of this emerging field was performed. Six databases were used to search for articles. The databases include the following: Academic Search Premier (a multidisciplinary database), Dissertations and Theses, Educational Resources Information Center, ICPSR Direct (Institute for Social Research at the University of Michigan), Psych Info, and Sociological Abstracts. The researcher's familiarity with the field allowed her to know that there would be a limited number of journal publications on the topic and more, though still not extensive, literature in book chapters and conference presentations. Due to the paucity of research on this area, the coverage criteria were broad to include as many applicable studies as possible. Thus, the literature review includes all identified documents that met the following requirements: 1) focused on a graduate school preparation program designed primarily to increase underrepresented students' participation

in graduate study 2) reported findings of at least one research or evaluation question related to students' of color interest in or matriculation into graduate school 3) published or presented studies in any of the following: peer-reviewed journal, professional conference presentation or proceedings (national or regional level), book chapter, an ERIC document, or an accepted dissertation.

Search Procedure

Phase I of the search used combinations of keywords related to the following three terms: 1) race/ethnicity (i.e., underrepresented, minority, and students of color), 2) degree plans (i.e., degree plans, educational plans, degree aspirations, and educational aspirations, and 3) graduate school (i.e. graduate study, graduate education, and postsecondary education). Phase II of the search used specific program and agency names like McNair, NSF (National Science Foundation), NIH (National Institutes of Health), MARC (Minority Access to Research Careers); and SROP (Summer Research Opportunity Program). Phase III used the names of authors known to have conducted studies related to GSPPs and the development of educational plans. The number of articles identified is disproportionately low given the significance of this topic and the longevity of the programs. Moreover, most of the articles identified and used have not been published, but are papers from conference presentations, dissertations, or ERIC documents. The next section of the literature review provides background information on the mission and structure of the GSPPs that are cited most in the literature.

Overview of Programs

Numerous initiatives are in place to expose students from traditionally underrepresented populations to the advantages of pursuing graduate study and to provide

experiences that increase their competitiveness for admission to graduate programs. This section provides an overview of the programs that appear frequently in the literature and in most cases referenced in the literature view of this study.

There is great similarity in the overall mission of GSPP programs, which is mainly to provide students with the information and resources needed to give serious consideration to pursuing a graduate degree. On the federal level, the National Science Foundation funds initiatives to increase the diversity of the nation's science, technology, engineering, and math (STEM) workforce. Programs include the following: the Louis Stokes Alliances for Minority Participation (LSAMP) program funded since 1991 and the Louis Stokes Alliances for Minority Participation (LSAMP) Bridge to the Doctorate (BD). Similarly, the National Institutes of Health (NIH) sponsors programs through the National Institute of General Medical Sciences (NIGMS). One of the largest of NIGMS' programs is the Minority Biomedical Research Support (MBRS) Award, created in 1972 and designed to prepare students for research careers in the biomedical sciences through funding faculty members' research, increasing the research capability of institutions serving significant minority populations, and increasing students' interest and skill level in biomedical research. The Minority Access to Research Careers Program (MARC), also under NIGMS, was created in 1977. Hoyte and Collett (1993) note the significance of MBRS and MARC efforts. In 1993, approximately 25% of all doctorates awarded to African American and Hispanic students in biology and chemistry were awarded to MBRS and MARC graduates. Additionally, as of 1993, 18 out of the top 20 institutions ranked according to the baccalaureate origins of African American doctoral recipients had either a MBRS or MARC program. The combined efforts of NIH and NSF resulted in more than $2 billion spent, between 1968 and 1998, to

increase participation of ethnic minorities and women in science (Baker, 1998). Thus, prompted by the desire to strengthen the U.S. STEM workforce and to diversify participation in post-baccalaureate education, federal agencies invest financial and human resources into a range of initiatives.

Another program funded by the federal government is the U.S. Department of Education's Ronald E. McNair program, which is among the TRIO college outreach programs designed to encourage and support students from economically disadvantaged backgrounds. McNair targets first generation college students, students with disabilities, students from underrepresented populations, and low-income students with strong academic potential and seeks to increase their graduate school matriculation rates.

Institutions of higher education are also spearheading individual and collaborative programs to bring parity to participation in graduate education. Programs that are frequently the subject of applicable research studies include the following: The Committee on Institutional Cooperation (CIC) Summer Research Opportunity Program (SROP) or (CIC-SROP), the Meyerhoff program at the University of Maryland, Baltimore County (UMBC) and the Research Education Support (RES) Program at the University of North Carolina at Chapel Hill (UNC-CH). Most programs appear to have similar missions and to be guided by similar philosophies. Program activities usually include the following: extensive research experiences for students, workshops and seminars to increase or reinforce interest in graduate school, assistance preparing for the Graduate Record Education (GRE) exam, support to participate in research conferences (including those sponsored by the program), social activities, and information about the graduate school application process. The programs operate under the theoretical premise that students have the aptitude and ability to earn

doctoral degrees but that some may need encouragement, the benefit of appropriate advising and appropriate experiences to pursue that path, as well as to increase awareness of graduate programs and opportunities. Furthermore, the programs assume that the services and activities they offer may positively expand or reinforce students' educational and career plans.

The programs differ in the type of disciplines involved, with Meyerhoff focusing only on STEM fields and others open to STEM, social sciences, and humanities. They also differ in their funding sources, with Meyerhoff receiving a combination of private and public funding, and CIC and RES receiving mostly public funding. Other unique differences among these three initiatives exist. CIC-SROP is a consortium of "Big Ten" universities and the University of Chicago (Eatman, 2001). SROP began in 1986 and is designed to increase underrepresented students' completion of doctoral study in areas where they can pursue research careers. The program is 8-10 weeks in length. Student-faculty pairings are based on students' interest and capabilities and the direction of the faculty members' research agenda. Program activities include educational and social activities and a CIC-wide Research Conference. RES differs in that it is the umbrella for several initiatives at UNC. In addition to providing opportunities for graduate and undergraduate students, it also serves medical and dental students. RES provides research opportunities in the physical, life, and social sciences, along with mathematics and technology and consists of both academic year and summer programs.

Graduate School Matriculation & Matriculation Plans

Considering that the overarching mission of GSPPs is to increase underrepresented student participation in graduate school, it is not surprising that much of the literature relates

to the degree to which programs succeed in producing students who formulate plans to pursue a graduate degree and students who enroll in graduate programs. The National Center for Educational Statistics reported that of all the underrepresented students who earned baccalaureate degrees from 1992-1993 only 8.8% had enrolled in graduate school (Foertsch, Alexander, & Penberthy, 1997). Underrepresented students who participate in GSPPs have substantially higher graduate school enrollment rates compared to the national level. One study related to the Ronald E. McNair program at Rutgers, the State University of New Jersey, found that of all the students who completed the program in its first two years of existence, 88% or fourteen of sixteen students from 1993, the first cohort, matriculated into graduate programs and 91% of the 1994 graduating cohort participants were accepted to graduate programs, with 82% or nine of eleven planning to enroll at the time the study was conducted (Thomas, 1994). These numbers are particularly high and encouraging, when you consider that McNair is a TRIO program, serving low-income, first-generation-college, underrepresented minority students. Another study involving McNair undergraduates, which yielded a response rate of 58% (n = 624), surveyed students at 61 institutions, indicated that 10% of 624 respondents planned to obtain a master's degree and 72% planned to pursue a doctorate (Williams, 2005).

In a study of NSF's former RCMS program, McHenry (1997) reported that more than 50% of the 1989-1994 RCMS graduates had matriculated into graduate programs. The population consisted of 57% African American students, 29% Hispanic, 11% Native American, and 45% female students. Response rate and procedure of the study were not indicated.

Studies of the University of Maryland, Baltimore County's (UMBC) Meyerhoff program report high proportions of participants enrolling in and graduating from professional and graduate programs (Maton & Hrabowski, 2004). Of the 86 participants in its first 10 cohorts, 29.1% had graduated from or were enrolled in a PhD or MD/PhD program. Compared to a comparison group of students who were accepted into the program but declined admission, Meyerhoff students were 5.3 times more likely to have graduated from or be enrolled in a graduate program. Additionally 43.8% of the non-Meyerhoff students did not continue to a STEM graduate program or to medical school, compared to only 29.1% of Meyerhoff students.

Maton and Hrabowski (2004) also state that the program's effectiveness appears to increase with time. While the first four cohorts experienced 18.3% of alumni pursuing or completing a PhD or MD/PhD the last 3 cohorts experienced 52.6% of alumni pursuing or completing a PhD or MD/PhD. Notably, Meyerhoff alumni graduated from science, technology, engineering, and mathematics (STEM) fields, which historically have extremely low participation rates for students of color.

The first graduating cohort of the Research Education Support Program, an academic year program, had positive post-baccalaureate outcomes (Frierson & Zulli, 2002). Half or seven of the fourteen participants who graduated in 1998 entered doctoral programs, while six enrolled in medical school but chose to conduct research as medical students. The next year saw similar success with all five of the graduating participants enrolling in graduate programs.

A follow-up study of participants in the CIC SROP 2003 cohort explored students' intention for graduate study (Johnson, 2005). Out of the 48 participants with useable

responses, 75% indicated that they plan to pursue a graduate degree. The specific breakdown was as follows: Doctoral degree 48%, Masters degree 19%, Joint degree (JD/PhD, MD/PhD) 8%. Of the remaining students, 6% were undecided on their post-baccalaureate plans, and 19% intended to pursue a professional degree. While there is a chance of selection bias, where students who benefited the most from the program or supported the programs' mission were the ones most likely to volunteer to participate in the study, the results show that the majority of those students plan to pursue a graduate degree.

Lewis and Frierson (2006) examined data for the 1998-2005 program cohorts of the Summer Pre-Graduate Research Experience Program. They found that 78.9% (n = 295) of students surveyed at the end of the program indicated that the program stimulated their desire to pursue graduate studies (48.5% strongly agree and 30.4% agree) and 83.9% or 234 indicated that they plan to enroll in a graduate program.

Results of a study of the University of Minnesota Summer Undergraduate Research Program also show positive outcomes related to graduate school enrollment and completion. Walters (1997) reports that the 1989-1992 program cohorts, which consisted of women and students of color, experienced rates of 62% to 72% completion or enrollment in graduate or professional degree programs.

According to a 1997 report of the CIC graduates who could be tracked, 52% of those from traditionally underrepresented populations had completed or enrolled in a graduate program, representing a 43% difference between the graduate school enrollment rate and those of CIC SROP participants and the national average for under-represented minorities (Eatman, 2001). The same study indicated that approximately half of the 1986-1999 CIC SROP population consisted of undergraduate science majors.

This section of the literature reviewed the available empirical studies that reported matriculation rates and plans following participation in GSPPs. Findings indicated the high proportion of former GSPP participants who matriculate in, complete, or have post-baccalaureate plans to pursue a graduate degree, indicating the possibility of a strong correlation between program participation and graduate school intentions and matriculation.

Participants' Perceptions of Program

In addition to literature delineating participant post-baccalaureate decisions, some studies have also focused on perceptions of and satisfaction with GSPPs. The synthesis of literature related to these outcomes is organized by the following categories: 1) Interest Measures 2) Competence Measures 3) Access Measures; and 4) Satisfaction Measures.

Interest. Given the variability in GSPP's structure and content, the high level of consistency is noteworthy. Most of the studies that include interest measures indicate students' interest in graduate school and research increased as a result of program participation. For the RES Program at UNC-CH, in terms of numbers, one study indicated that more than 75% of students reported increased interest in graduate school and more than 50% reported increased interest in research careers (Booker & Frierson, 2002; Smith, Lewis, & Frierson, 2006). These findings are based on students' responses to a program exit survey administered at the end of the program. Several reasons were given for the heightened interest. Exposure to the research process and environment (Johnson, 2005; Frierson & Zulli, 2002; Smith, Lewis, & Frierson, 2006; and Walters, 1997) was cited, in that it changed students' views of research from boring and isolating to that of interesting and engaging. Similarly, development of meaningful relationships with graduate students and faculty led to positive perceptions of the people involved in research, replacing students' preconceived

notions that those individuals lacked social skills and personality. Thus the program allowed students to develop a more accurate and positive perception of research and graduate school. This new perspective, in turn, made students more comfortable in the research environment and apparently increased their commitment to pursuing graduate study.

Competence. The literature also documents GSPP's effectiveness in fostering students' graduate school and research competence. In a study of pre- and post-McNair participants, post-McNair participants had higher levels of academic, research, and social self-efficacy, [$F(3, 296) = 108.2$, $p < .01$,] indicating that program participants had more confidence in their academic, research, and social ability to pursue and complete a graduate program of study (Williams, 2005). Regarding academic self-efficacy, the two areas where students were most confident were their ability to obtain a strong letter of recommendation for graduate school from at least one professor and their ability to choose a graduate school appropriate to their needs. They were least confident in their ability to score high enough on the Graduate Record Examination (GRE) to gain admission to one of their top three graduate school preferences. The research self-efficacy items showed that students were most confident in their ability to discuss research ideas with a professor and least confident in their ability to choose appropriate data analysis techniques. The social self-efficacy items indicated that students were most confident in their ability to ask a professor to be a mentor. The lowest mean score, although still relatively high (7.37 on a scale of 1-10) was comfort in visiting a professor in his/her home. These findings show that the McNair participants were efficacious at many tasks critical for enrolling and succeeding in graduate school.

In addition to self-report indicators of competence, there is some data regarding faculty-mentors' perceptions. Frierson (1996) interviewed faculty preceptors in a research

program to assess their perceptions of students' performance. The faculty members rated the students' ability to effectively conduct research more positively than any other aspect of the program. Participants' competence levels are also reflected in studies that conclude that the programs helped participants prepare for the academic and emotional challenges of graduate school (Booker & Frierson, 2002), enhanced their skills and knowledge (Delatte, 2004), and "validated that they were capable of graduate or professional school work" (Walters, 1997 p. 28).

Access. Another aspect of GSPPs is their success in providing students access to research opportunities that may not otherwise be available. Most programs assist students in securing research positions by matching them with faculty members who agree to serve as faculty mentors/research trainers. One study found that 85% of the study participants (16 of 19) stated that if it had not been for the program, they would not have participated in academic-year research as undergraduate students (Frierson & Zulli, 2002). Because the program often worked on the students' behalf to make the initial contact with faculty, students' anxiety did not preclude them from research engagement. Additionally, students reported that having program staff assist and advise them in choosing a research site made the process easier to navigate.

Several studies show that once students are in the programs, they have access to a new network of people, events, and resources (Frierson & Zulli, 2002; Johnson, 2005; Smith, Lewis, & Frierson, 2006). Program activities promoting enhanced access include attending meetings with faculty-mentors, seminars, conferences, and participating in lab meetings. These activities are critical to establishing and developing a professional and social network related to graduate education.

Satisfaction. Findings concerning students' satisfaction with program components are generally positive and broad in scope. Based on responses to Likert-type and open-ended questions on an exit survey, students' perceptions of the overall program experience show that they find the programs worth their time and effort, and that they would recommend the program to others (Booker & Frierson, 2002; Smith, Lewis, & Frierson, 2006). Interviewees in Walters (1997) study reported that they were pleased with the overall environment of their summer program. While some students may have experienced difficulty with an academic or professional aspect of the program, they reported that the social support made up or compensated for the challenges in other areas. Some studies investigated differences in perceptions of satisfaction based on gender. Despite the fact that GSPPs targeting underrepresented minority students tend to have female to male student ratios of more than 2:1, and that women now outnumber men in graduate enrollment for all ethnic groups, Riggins and Frierson's (1996) analysis of exit survey data found that male and female students only differed on two variables. When asked about the extent to which the program met their expectations and the extent to which the program was worth their time and effort, male students reported more positive perceptions than female students. This finding is surprising given the low number of males that typically participate in GSPPs. It is also encouraging because it shows that the programs can accommodate men just as well as women, and that despite their low numbers, the men find the experience to be worthwhile.

Another study investigated differences in students' satisfaction based on the ethnicity and/or gender of their faculty-mentor (Frierson, Hargrove, & Lewis, 1994). Near the end of a nine-week summer research program, students with Black or female mentors indicated more positive interactions with their mentor at the $p \leq .05$ level. Area of research, natural

science vs. social science and humanities, was also used to compare students' level of satisfaction. Chi square test analyses indicated no significant differences in the quality of the mentoring relationship related to field of study, overall impression of the program, or perception of research, research project, or graduate school. Inquiry into students' satisfaction shows that the program activities appear to be effective and appropriate.

Summary of Literature

In summary, the limited literature on GSPPs indicates that 29-84% of program participants pursue and/or state plans to pursue graduate study. Despite this broad range, these proportions tend to be well above the national averages for underrepresented students. An examination of the investigative literature on GSPPs reveals several limitations. First, many of the studies involve small sample sizes. This is often because studies involve cohorts that may have only 10, 20, or 40 participants. Secondly, and perhaps most problematic, is the fact that few studies examine the link between program experience and positive program outcomes, with the goal of explaining possible linkages. While many factors contribute to students' postbaccalaureate educational choices, it is important to understand how program outcomes are associated with plans for graduate study. Thirdly, it is important to note that there is very little information on the challenges faced or negative outcomes (Thomas, 1994 is one exception) of studies related to GSPPs. Perhaps individuals are reluctant to report challenges or perhaps the questions and methods used thus far have prevented us from discovering them.

The fact that this line of inquiry emerged as recently as the early 1990s may explain the limited number of studies available. However, in light of the benefits afforded to underrepresented students by graduate education, it is important that we understand more

about their experiences in GSPPs and the variables or outcomes related to graduate school enrollment. Many of the limitations that were noted can be addressed with moderate effort and resources. Given the current emphasis on accountability, this is an opportune time to examine our research focus and design. As noted by Frierson and Zulli (2002), "In conclusion, it is important to note that this work is not intended to be an endpoint but instead an initial effort to determine ways that intervention programs can successfully increase minority student participation." By considering findings from the initial effort and extending our knowledge and techniques, we ensure that the field continues to advance. This study seeks to add to the foundation for a new line of research directed at modeling programs' influence on students' educational plans, as well as exploring the applicability of theoretical frameworks that have not typically been applied to GSPPs.

Theoretical Framework

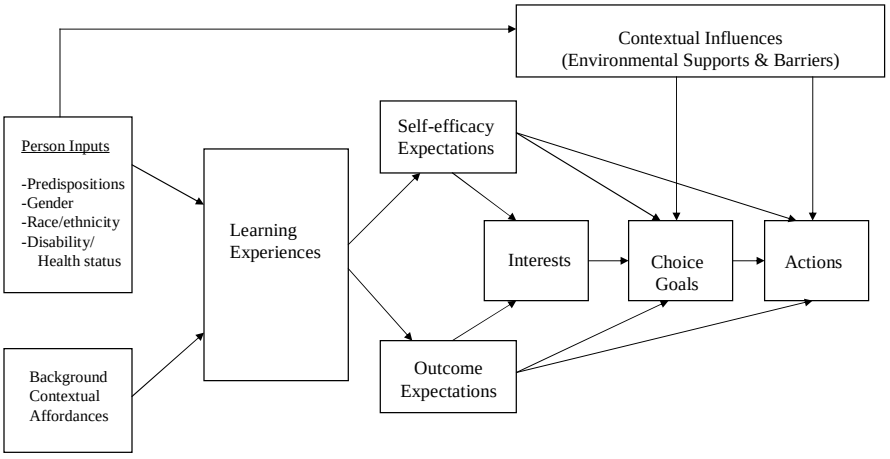
The theoretical framework guiding this study is an adaptation of Lent, Brown, and Hackett's (1994) Social Cognitive Career Theory (SCCT). SCCT suggests pathways that explain how our experiences and perceptions of those experiences ultimately influence three phases of career development: 1) interest 2) goals or choices to pursue particular academic and occupational options and 3) performance and persistence in chosen academic and occupational pursuits (Lent, Brown, and Hackett, 1994). Empirical evidence supporting the application of SCCT to academic and career choice is found in a wide range of studies, from those investigating students' intention to pursue a career in the sport and leisure industry (Cunningham, Bruening, Sartore, Sagas, & Fink, 2005) to African-American college students' intentions to study math (Waller, 2006).

SCTT is based on Bandura's social cognitive theory (1986), which views behavior as a dynamic and reciprocal interaction between person, behavior, and environmental variables. The dynamic nature of the relationship implies fluidity and change while the reciprocity implies that the relationship is not unidirectional, but rather the variables influence each other. Social cognitive theory emphasizes the role of cognitions, particularly how they are shaped by learning experiences, in determining our behavior. More specifically, it posits that behavior is the product of self-regulatory and self-reflective processes, allowing individuals to both influence and be influenced by their environment. SCCT adapts the core social cognitive principles and extends them to vocational domains (Lent, Brown, & Hackett, 1994; Fouad & Guillen, 2006).

Social Cognitive Career Theory is particularly appropriate for the current study for several reasons. First, it is one of few theories that is conceptualized to explicitly apply to both educational and occupational pursuits. It views them as developing in parallel to one another, often being influenced by the same variables and through similar processes. This is significant because an individual's career options are often constrained or expanded by their level of education and their field of study. Moreover, individuals may make educational choices based on the career they plan to pursue and vice-versa. The second reason SCCT is suitable for this study is its focus on variables that "are amenable to change" (Ali & Saunders, 2006). While factors such as SES (socio-economic status) and parent educational level may contribute to educational and career attainment, they are not easily amenable to change. By incorporating variables that are more dynamic, the framework affords individuals a sense of autonomy and recognizes the potential for career development to be shaped by interventions. Lastly, SCCT asserts that career development is the product of

learning opportunities to which we are exposed. The program examined in the current study provides the opportunity to investigate educational choice within the context of one particular learning opportunity. While each student's program experience may differ, in general, they are exposed to the same activities, within similar contexts.

As stated previously, social cognitive variables are essential to SCCT. Additionally, an important focus of SCCT is the hypothesized relationship among the variables in the theory. The following section describes the individual variables that comprise the SCCT model and explains how the variables relate to one another. Figure 1. represents Lent, Brown, and Hackett's SCCT model.



Adapted from "Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance" by Lent, Brown, and Hackett, 1994

Figure 1. Model of Social Cognitive Career Theory

Goals/Choice Intention

Goals are symbolic representations of a desired outcome towards which an individual is working (Lent, Brown, & Hackett, 1994). Bandura (1986) defines goals as the intention to engage in a particular activity or to achieve a particular outcome. Goals are significant because they can motivate individuals to plan and take appropriate action to achieve goal attainment. In educational and career development literature, goals are expressed in various ways, including plans, intentions, and expressed choice (Lent, Brown, & Hackett, 1994).

SCCT suggests that goals are influenced both directly and indirectly by all of the core person variables including: interests, outcome expectations, and self-efficacy expectations. Direct influences are also obtained from proximal environmental factors or contextual variables, while indirect influences are obtained from learning experiences and person inputs (i.e. gender, ethnicity).

Interest

Interest is an important motivational factor, representing patterns of likes and dislikes. Interest in an activity is associated with increased knowledge, value, and positive feelings toward the activity (Hidi & Harackiewicz, 2000). Additionally, interest facilitates greater involvement and further skill development for a task (Lent, Brown, & Hackett, 1994). In SCCT, experiences and environment are indirect but critical factors to interest development, given that our experiences and environment are major determinants of the activities to which we are exposed. Moreover, interests are directly influenced by self-efficacy beliefs and outcome expectations, in that we are more likely to maintain interests in activities for which we think we will excel and for which we value the anticipated outcomes.

Outcome Expectations

According to SCCT outcome expectations are our beliefs about the likely consequences of engaging in a particular activity and the relative value that we attribute to the anticipated outcomes of those behaviors (Lent, Brown, & Hackett, 1994). This definition departs slightly from the traditional view of outcome expectations that does not include the value component. Outcome expectations are informed by our self-efficacy beliefs and experience, with interest in an activity increasing when we anticipate that the activity will lead to a highly valued outcome, and interests decreasing when we do not anticipate a valued outcome resulting from our behavior (Bandura, 1989). The significance of outcome expectations lies in the fact that if we deem the consequences of particular actions to be significant and worthwhile, and we feel efficacious to complete the task, then our interest and commitment to the related goals increase. According to Lent and Brown (2006, p.17), career-related outcome expectations can be described as "people's beliefs about the extent to which they will be able to satisfy their primary values if they were to pursue particular career paths." Essentially, outcome beliefs have been conceptualized in a variety of ways: the belief that particular actions will lead to a desired result, our belief that the benefits of an action outweigh the cost, and the value one places on the expected outcome (Lent, Brown, & Hackett, 1994).

Outcome expectation and task value are important aspects of career choice and development. For example, Eccles (Parsons), Adler, and Meece (1984) concluded that task value was the most significant predictor of students' educational plans and Meece, Wigfield, and Eccles (1990) reported that the value associated with a particular academic subject was the most powerful predictor of enrollment intentions. Similarly, Irving and Hudley (2005) found that outcome expectations predicted student course selection. Thus, outcome

expectations are central to academic and career choices in that individuals are more likely to engage in behaviors and make choices that they anticipate will result in outcomes that they value. According to SCCT, outcome expectations are related to the other variables through a direct influence on interest and goals/choice intentions and through an indirect influence on goals/choice intentions.

Self-efficacy

As defined by Bandura, self-efficacy represents a person's belief about how well they can perform a given task, or their conviction of how successful they will be in achieving a certain activity (1986). Efficacy expectations influence a range of behaviors, including, what activities we choose to participate in, how much effort we exert, how long we persist when faced with obstacles or failure, and our physiological state (Bandura, 1986). In terms of career development, early research relating self-efficacy theory to educational and career domains posits that efficacy expectations influence the range of educational and career options that we consider, our persistence, and ultimately our level of success in desired educational and career pursuits (Betz & Hackett, 1983). It is important to acknowledge the value of efficacy beliefs in the context of students' educational and career aspirations because they affect students' perceptions of what goals are realistic and thereby influence achievement, attitudes, and interest. For example, if a student does not think it is realistic to pass a given course, he is unlikely to put forth effort, will not have a positive attitude about the course, and will likely lose interest. Lent et al. (1994) and Hackett and Betz (1989) maintained that ability and outcomes are mediated by efficacy beliefs.

According to SCCT, self-efficacy influences outcome expectations directly and influences interest directly and indirectly through outcome expectation. As described by

Bandura, self-efficacy is influenced by learning experiences, specifically the feedback that we receive in such experiences, the role models we have, our performance, and our perceptions and cognitive appraisals of the experiences (Bandura, 1986).

Learning Experiences

Learning experiences are one of the primary gateways to exposure and engagement in educational and career related activities, providing access to people, information, and resources that contribute to individuals' perceptions of potential career pursuits. Through participation in learning experiences, individuals achieve various levels of success and subsequently form judgments about their ability. Ability judgments, or self-efficacy beliefs, can be enhanced in learning experiences through the four primary sources identified by Bandura (1977): personal performance accomplishments, vicarious learning (modeling), social persuasion, and physiological states. Personal performance accomplishments or mastery experiences occur when an individual succeeds at a task that is moderate to high in difficulty. Mastering a task is one of the most powerful ways to influence self-efficacy beliefs because when we achieve success we are motivated to repeat the activity and to engage in similar tasks. Additionally, past mastery of a task tends to increase our persistence when we are faced with challenges. Examples of personal performance accomplishments within GSPPs include participants conducting a literature review and producing a written product, as well as participants learning to use a new piece of laboratory equipment properly and without assistance. Accomplishment of these tasks contributes to enhanced self-efficacy beliefs regarding research.

Vicarious learning or modeling contributes to enhanced self-efficacy beliefs because we are more likely to believe that we can succeed at a task when we see a similar social

model succeed at the same task. Modeling allows one to acquire skills and knowledge through observing someone else. Wherein, we believe that if we use the same strategies that we observed, then we should achieve similar outcomes. For example, if a student attends a research talk given by her faculty mentor and an intense question and answer session follows, the student may be caught off guard by the tone and intensity of the exchanges. When her faculty mentor diffuses the situation, answers the questions, and restores a sense of order to the session, the student is impressed and now has ideas about how to react if or when she is in a similar situation. The experience equipped her with possible wording to use and other strategies to implement.

Verbal encouragement, the third source, consists of giving positive feedback and conveying supportive appraisals of the person's ability and performance. Examples include commending a student for the quality of the work they completed or telling a student that you are confident that they will do a good job on a task. Physiological state, the last source, relates to somatic and emotional states. Extreme nervousness and anxiety about a task are related to low self-efficacy beliefs, while high self-efficacy beliefs are associated with excitement and positive emotions. For example, a student with low self-efficacy beliefs is likely to be more anxious about leading a discussion in a lab meeting than a student with high self-efficacy beliefs. Consequently, learning experiences provide the environment for individuals to assess their capabilities and ideally, the opportunity to enhance their capabilities and their perception of their ability. Moreover, in addition to providing a context to enhance efficacy beliefs, learning experiences also help shape outcome expectations by making individuals aware of response-contingent outcomes, or the likely consequences of

specific behaviors. Therefore, learning experiences make it possible to enhance self-efficacy beliefs and to inform outcome expectations.

Contextual Influences Proximal to Choice Behavior

SCCT asserts the influence of contextual or environmental supports and barriers on career and educational development. Supports are considered factors that facilitate positive experiences and perceptions, while barriers are viewed as factors that hinder progress and lead to negative experiences and perceptions. In line with the cognitive emphasis of the theory, perceptions of supports and barriers are based on both subjective and objective features of the environment, relying on the individual's interpretation (Lent, Brown, & Hackett, 1994). Perceptions of strong support are related to increased likelihood of selecting a goal and conversely, perceptions of substantive barriers are related to decreased likelihood of choosing the goal. In SCCT contextual factors contribute to the relationship between interest and choice goals, helping to determine if interests are translated into goals (Lent, Brown, & Hackett, 2000) and subsequently influencing the level of student persistence and performance level.

Summary of SCCT

Essentially, SCCT provides a theoretical framework that encompasses constructs related to one's perceived ability, values, interests, and goals, while incorporating important contextual factors. A summary of how the variables relate to and influence each other follows.

SCCT posits that our experiences expose us to certain learning situations. As a result of our perceptions of the experiences, two important things happen: 1) we form judgments about our abilities and 2) we determine the value of anticipated consequences of actions

associated with the experience. Known as self-efficacy beliefs and outcome expectations, these ability judgments and value expectations subsequently influence our interest in particular educational or career domains. More specifically, perceptions of high- ability coupled with positive outcome expectations are hypothesized to promote or sustain interests, where in perceptions of low- ability and negative outcome expectations are hypothesized to lead to disinterest.

Following interest development, the theory postulates that interests are translated to choice/goal decisions to pursue a particular pursuit when an individual has high interest and does not expect to encounter insurmountable barriers. SCCT uses the term contextual factors to refer to "supports" that encourage people to set the goal and "barriers" to refer to factors that deter individuals from setting the goal. Thus, a combination of interest and the perception of support or lack of significant barriers is associated with the choice/goal to pursue a particular educational/career path.

SCCT's utility can be attributed to its applicability to both academic and career research, its focus on variables that can be changed, and its emphasis on the significance of learning opportunities. The model tested in the current study is based on SCCT and contains slight modifications to reflect the population and program under study.

The model developed for the current study is based on the tenets of SCCT in relation to the program context. The model holds that the program experience, which serves as the learning experience, is comprised of three variables: 1) quality of faculty preceptor relationship 2) perception of research environment and 3) satisfaction with the program experience. The elements of the program experience have a direct relationship on two primary program outcomes which are increased knowledge of graduate school and research

(Knowledge) and outcome value of program participation (Outcome Value). Subsequently, Knowledge and Outcome Value directly influence the extent that the program stimulated participants' interest in pursuing graduate study. Chapter three provides a detailed explanation of the variables represented in the model and Figure 2. contains the conceptual model.

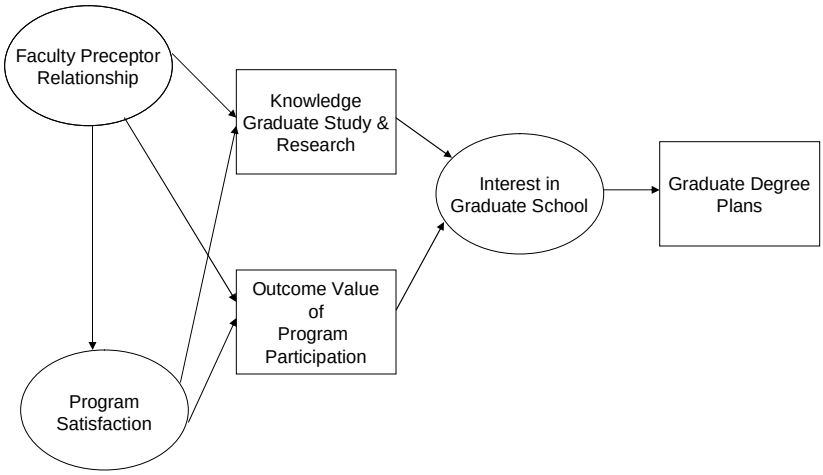


Figure 2. Conceptual model of program outcomes associated with educational plans for a graduate degree.

Research Questions and Hypotheses

Based on the overarching question: In what ways are the program outcomes associated with participants' post-program plans to pursue graduate study? This study was guided by the following research questions:

1. How well does the proposed model represent the interrelationships of program outcomes?
2. To what extent does the proposed model predict participants' post-program educational plans to pursue graduate study?

Hypotheses. Several hypotheses were developed from the research questions. The hypotheses are provided in the following section.

Hypothesis 1: The proposed model will have good fit to the data in explaining the effects among program outcomes.

A. Interest in graduate study will have a direct effect on educational plans for graduate study.

B1. Knowledge will have a direct effect on interest in graduate study.

B2. Knowledge will have an indirect effect on plans for graduate study, through Interest.

B3. Outcome Value will have a direct effect on interest in graduate study.

B4. Outcome Value of will have an indirect effect on plans for a graduate degree, through Interest.

C1. Faculty preceptor relationship will have a direct effect on program satisfaction.

C2. Faculty preceptor relationship will have a direct effect on Knowledge.

C3. Faculty preceptor relationship will have a direct effect on program participation outcome value.

C4. Faculty preceptor relationship will have an indirect effect on Interest, through Knowledge and interest.

C5. Faculty preceptor relationship will have an indirect effect on plans for a graduate degree, through Outcome Value and Interest.

D1. Program satisfaction will have a direct effect on Knowledge.

D2. Program satisfaction will have a direct effect on program participation outcome value.

D3. Program satisfaction will have an indirect effect on plans for a graduate degree, through Knowledge and Interest.

D4. Program satisfaction will have an indirect effect on plans for a graduate degree, through Outcome Value and Interest.

Hypothesis 2: The initial model will have moderate to good fit and explain at least 15% of the variance associated with the variable plans for a graduate degree.

This chapter summarized and critiqued extant literature on GSPPs and discussed SCCT as a conceptual framework appropriate to use in this field. Additionally, the research questions and hypotheses guiding the current study were discussed. The next section outlines the methods employed in this dissertation.

CHAPTER 3
Methods

Overview

The current study developed and tested the fit of a model designed to predict the program outcomes that are associated with participants' development or maintenance of educational plans to pursue graduate study following participation in the SPGRE program. This chapter explains the methods used to conduct the study. First, the data source is described, then the data analysis technique is explained, and finally, the procedures guiding data analysis and presentation are discussed.

Data Source and Instrument

Data for the study were taken from the 30 item SPGRE End of the Program Questionnaire (Appendix A), which is administered each year during the last full day of the program. The self-report questionnaire measures students' perceptions of the program. The questionnaire consists primarily of Likert-type responses with some open-ended questions. The items are based on four (1=No, Definitely not to 4=Yes, Definitely) and six-point (1=Very Unfavorable to 6= Very Favorable) scales. The questionnaire is anonymous to encourage honest responses. Internal reliability analysis (Cronbach's alpha) for the instrument yielded a coefficient of .82 based on 28 items. Advantages of using this instrument include the ability to obtain students' immediate feedback regarding their program experience and their post-baccalaureate plans. Additionally, the content of the questionnaire has remained consistent each year since the program's beginning, with only

minor changes (i.e. the addition of the ethnicity question in 1991 and changes to the forced-choice research disciplines provided).

Data Analysis Technique

Structural Equation Modeling (SEM) was used to build and test the adequacy of the model. SEM is an extension of regression and classical path analysis. It allows the researcher to specify a model based on theory and to test the model's ability to reproduce the data. The process yields information about the strength of relationships between variables or paths and the amount of variance explained each variable. Several factors support the selection of SEM as the analytic technique. First, it permits the inclusion of observed and latent measures in the model. Latent constructs are not observed directly, but instead are comprised of two or more indicators or factors (Hoyle, 1995). Using latent constructs permits the researcher greater flexibility in operationalizing variables, as compared to using one measured item. Another advantage of using latent constructs is the reduction of measurement error in the estimation process (Hoyle, 1995). Whereby regression and classical path analysis assume perfect measurement of variables, SEM can account for measurement error, thereby decreasing bias in regression coefficient estimates. A second benefit of using SEM is that it allows testing of complex relationships between variables. More specifically, it permits variables to be tested as both a predictor and an outcome and it permits simultaneous estimation of several paths, allowing the researcher to estimate multiple outcomes and to assess the model as a whole. The ability to test the model as a whole is an advantage over traditional regression techniques where each outcome is tested in isolation. Thirdly, SEM estimates both direct and indirect effects of variables, facilitating testing of mediation. In sum, Byrne (2001) has asserted that using SEM is advantageous because of the

flexibility it permits in the design and fit evaluation of models. Mplus version 4.1 was used to conduct analyses. Mplus was selected because of its suitability for a dichotomous outcome variable and its ability to handle ordered categorical data through the use of WLSMV (Weighted Least Squares with Mean and Variance adjustment) estimation, for data that are nonnormally distributed.

Procedures

Generation of data subsets. A random number generator was used to divide the data into two groups for the purpose of cross validation. Thus, sample one, the derivation sample, was used to test and modify the initial model and sample two was used to estimate the fit of the final model.

Descriptive analysis. Descriptive statistics were generated using SPSS 15.0. Demographic data pertaining to participants' ethnicity, gender, type of college attending, and academic rank will be provided, as well as an analysis of missing data, means and standard deviations, and reliability estimates for scales.

Operationalization of measures. This section discusses the operationalization of measures. The mean and standard deviation for observed variables and the factor loadings and R-Squares for latent variables will be provided in chapter four.

The dependent variable, referred to as "graduate degree plans," is measured by participants' response to an open-ended question asking them to indicate their post-baccalaureate plans. Responses were coded "0" for any response that did not indicate graduate education and "1" for responses indicating graduate study. Responses related to pursuing a professional degree such as MD or JD were coded as "0," since the goal of the program is to prepare students for graduate school. The coding scheme for the major

outcome variable is provided in Appendix B. The one week test-retest reliability analysis of this variable (n=38), conducted with the 2006 program cohort resulted in Kendall tau's coefficient of 1.00.

Selection of the independent variables was guided by Social Cognitive Career Theory (SCCT), literature related to GSPPs, and statistical analyses. Thus, the following variables were examined: a) quality of faculty preceptor relationship; b) program satisfaction; c) increased knowledge of graduate school and research; d) outcome value of program participation; e) increased interest in pursuing graduate study; and f) educational plans for graduate study. While all of the variables are program outcomes to some extent, variables a and b theoretically represent the SPGRE program experience, variables c, d, and e represent the program outcomes, and variable f is the major outcome variable, educational plans for a graduate degree.

Interest in graduate school. Interest is gauged by one item, on a six-point scale, to assess the extent to which program participation stimulated participants' desire to pursue graduate study.

Outcome value of program participation. The current study uses the term outcome value rather than outcome expectation, which is used in Lent, Brown, and Hackett (1994). While the use of outcome value in the current study is a slight modification of terminology, its meaning remains consistent with SCCT. As indicated in Chapter Two, Lent, Brown, and Hackett's (1994) definition of outcome expectations refers to the value an individual places on expected outcomes. Thus, the current conceptualization emphasizes the valence component, which is frequently unacknowledged in studies using SCCT (Lent, Brown, Schmidt, Brenner, Lyons, & Treistman, 2003).

Outcome Value (Outcome) is measured by one questionnaire item related to how much value students attribute to the general costs and benefits of participating in the program. Respondents used a six-point scale.

Knowledge of graduate school and research. The Knowledge variable is based on participants' perception of how much their knowledge of the processes involved in graduate school and research increased as a result of program participation. While Lent, Brown, and Hackett's (1994) SCCT model uses an efficacy measure, this study replaces the efficacy measure with Knowledge. The change was made for two primary reasons. First, efficacy beliefs have been found to be more predictive of performance rather than intentions or plans, which are the outcome variable in the current study. Therefore, since the current study pertains to plans, knowledge is the more appropriate measure. Secondly, research shows that lack of knowledge about what is involved in research and doctoral study is significantly associated with ethnically underrepresented students' disinterest in doctoral study (Smith, Lewis, & Frierson, 2005; Fleming, 2005). Similarly, Carter (2001) and Boyce (1997) have asserted that African American students tend not to be very informed about postbaccalaureate education options when they enter college and therefore undergraduate experiences play a valuable role in increasing their knowledge and awareness of postbaccalaureate options. The item is measured by one questionnaire item based on a four-point scale.

Latent variables. Latent variables are unobserved factors. Our understanding of what they represent is based on the covariances of their measured items. The initial model includes two latent variables: program satisfaction and quality of faculty preceptor relationship. Figure 3. depicts the measurement models that were tested.

Program satisfaction. Program satisfaction is a latent variable comprised of three questionnaire items related to the following: 1) satisfaction with decision to participate in program 2) overall impression of program 3) and whether they would recommend the program to others. Item one was measured on a four-point scale and items two and three were measured on a six-point scale.

Quality of faculty preceptor relationship. The core of the program is completion of a research project under the guidance of a faculty mentor. The program is designed in such a way that the mentor is the student's primary socialization agent to graduate level research. The latent variable, quality of the faculty preceptor relationship is comprised of three items that assess the overall quality of the relationship, the extent to which the relationship was positive and satisfying, and how productive the student perceived the relationship to be. Respondents used a four-point scale for one of these items and a six-point scale for the remaining two items.

Estimation of measurement model. Anderson and Gerbing (1988) suggest a two-step or building process to modeling, whereby the measurement model is tested prior to the structural model. The measurement model represents the relationship between the underlying construct and its indicators. Testing the measurement model first provides statistics on the amount of shared variance between indicators and factors and thus assesses how well the construct represents the indicators (Kline, 1988). If the indicators fail to have good fit with the latent construct, the measurement model should not be inserted into the general model without modification. Confirmatory factor analysis (CFA), a special type of SEM, was used to estimate the measurement model and provide data on how well the indicators represent their underlying construct. The fit of the measurement model was based

on two criteria: 1) significance of factor loadings, which represent the weights between the item and the factor and 2) degree of overall fit. Significance of factor loadings at the $p < .05$ level will be considered acceptable. An explanation of the criteria for the overall measurement model follows.

Fit indices for latent variables. The measurement models that were tested in confirmatory factor analysis consisted of three indicators per variable, making them just identified, and incapable of producing fit indices. Therefore, in order to obtain fit indices the measurement models were tested together as a two factor model with six indicators.

The absolute fit indices that were evaluated include the chi-square statistic and standardized root mean residual. The chi-square statistic was assessed to determine the fit between the specified model and the actual data. A non-significant chi-square value is desirable because it denotes little or lack of difference between the model and actual data. The closer the chi-square statistic is to zero, the better the fit. The Standardized Root Mean Square Residual (SRMR) indicates the mean absolute residual of the sample or observed correlation matrix and the predicted correlation matrix. Because SRMR is a badness of fit index, smaller values indicate better fit with values less than .08 reflecting good fit (Kline, 2005). Relative or incremental fit indices evaluated included the Nonnormed fit index (NNFI) also known as the Tucker-Lewis index (TLI) and the Comparative Fit Index (CFI). TLI is a statistical comparison of the lack of fit of the specified model to a baseline model, adjusting for the degrees of freedom. CFI is a measure of how much better the hypothesized model fits in comparison to a null model where there is no relationship between the variables (Kline, 2005). TLI statistics and CFI values higher than .95 are considered favorable (Hu & Bentler, 1999). Finally, Root Mean Square Error of Approximation (RMSEA), which

assesses misfit based on degrees of freedom was evaluated, with a value less than .06 considered acceptable.

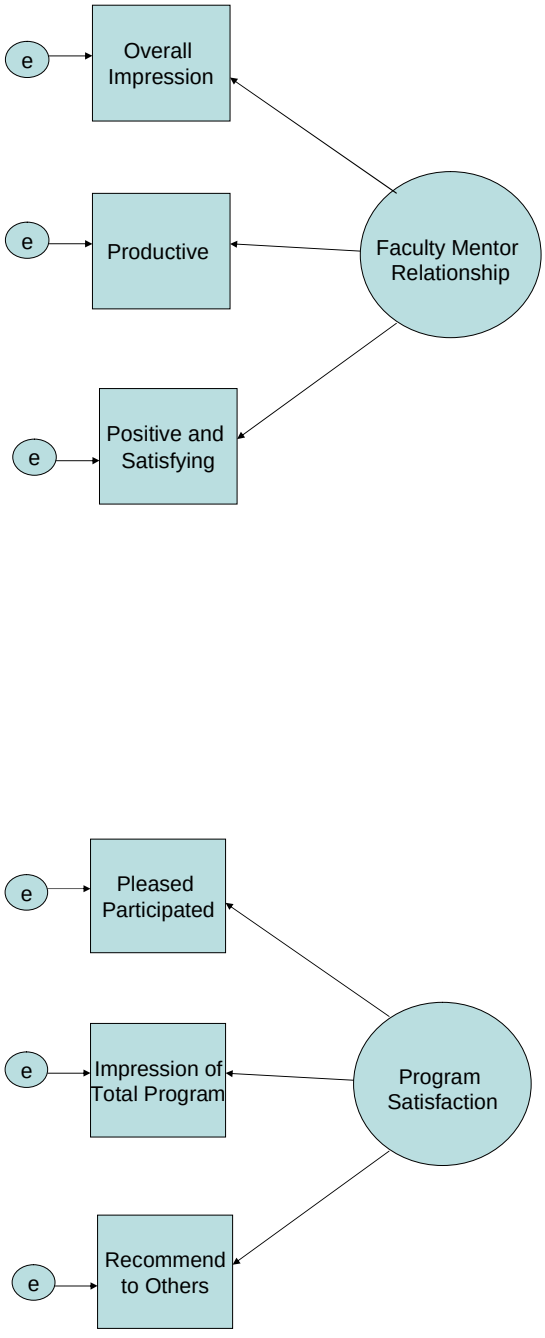
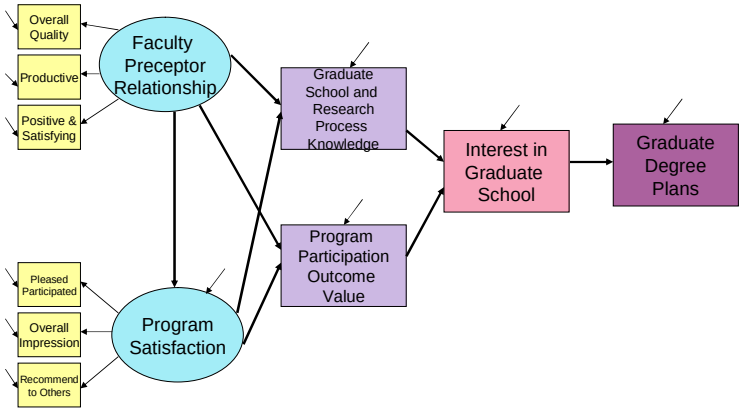


Figure 3. Proposed measurement models of faculty mentor relationship and program satisfaction.

Estimation of Structural Model. Following acceptable specification of the measurement models, the structural model, which represents the relations between the latent variables from the measurement model and the observed variables, will be estimated.

Initial model. The initial full structural model is presented in Figure 4. The proposed model contains two latent constructs, comprised of three indicators each; three observed variables; and one major outcome or dependent variable.

Figure 4. Initial structural model of the association between program outcomes and plans to pursue



Model evaluation. Structural model adequacy was assessed on component and overall fit indices. Specifically, the following were evaluated with the same criteria indicated for the measurement model: a non-significant chi square statistic, Standardized Root Mean Square Residual (SRMR), Nonnormed Fit Index (NNFI)/Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI), and the Root Mean Square Error (RMSEA) indices. Additionally, the magnitude of parameter estimates, the standard error, and the squared multiple correlations were examined. Modifications to the model were based on the aforementioned statistical criteria along with theoretical and practical considerations.

Cross validation. Following estimation and evaluation of the initial model, modifications will be made if necessary. The modifications will be made in an exploratory manner, producing a model that can subsequently be cross-validated with the second data subset. It is important not to explore and confirm on the same data, as modifications to the initial model are based on achieving fit to the actual data that you would use to confirm fit.

Conclusion

This chapter outlined the methods guiding the current study. The data source, analytic technique, and procedures guiding data analysis were provided. The data for the study were taken from the SPGRE End of the Program Questionnaire that is administered each year during the last days of the program. SEM techniques are used to estimate the fit of the model, or to determine how well the hypothesized model reproduces the data. The dataset will be divided into two sub-samples, with sample one being used to test and modify the initial model and sample two used to estimate and evaluate the final model. Findings are presented first for sample one and then for sample two.

CHAPTER 4
Results

This chapter presents the results of the statistical tests conducted to assess the fit of a hypothesized model of the interrelationships of program outcomes and the association between program outcomes and educational plans to pursue graduate study, for SPGRE participants over an 18-year period. Data were available for all program years from 1988 – 2006, with the exception of program year 1999. The response rate for the SPGRE end of the program questionnaire was 96%. Model estimation and evaluation were conducted in two stages, first with sample one and then again with sample two. The first section of this chapter presents descriptive statistics for demographic characteristics and the dependent variables represented in the model. The second section provides the results of the CFA and the third section describes the results of the estimation of the full structural model, model exploration, and model estimation for sample two.

Descriptive Statistics of Participants' Demographic Characteristics

SPSS 15.0 was used to obtain descriptive statistics of participants' demographic characteristics. The descriptive statistics for both samples were similar, with one minor exception, academic rank. Sample one had slightly more students who would be rising seniors, 84.5% compared to 79.5% and sample one had fewer juniors, 13.1% compared to sample two at 15.9%. Moreover, sample two had slightly more students who were fifth year seniors or who had completed the bachelor's degree, 3.4% compared to 1.2%. These minimal differences were not perceived to be problematic.

Missing data were examined for patterns and potential biases. It was determined that sample one had 16 cases (4.6%) of missing data pertaining to the outcome variable, one of the program satisfaction indicators had two cases with missing data and one had seven cases with missing data, while one of the faculty relationship indicators had missing data for two cases. Analysis of missing data for sample two indicated 21 cases (6.1%) of missing data for the outcome variable, three cases related to faculty preceptor relationship, ten related to program satisfaction, and one case each for the variables Outcome Value and Knowledge. Given that there did not appear to be a pattern to the missing data and that the majority of the missing data were related to the major outcome variable, imputation was not conducted and the cases were deleted from analysis. Table 1 provides a summary of participants' ethnicity, gender, and academic rank after deleting cases that were missing data for the major outcome variable.

Table 1

Demographic Characteristics of Participants by Sample

Characteristic	Sample 1 (N)	Percentage	Sample 2 (N)	Percentage
Ethnicity				
African American	266	80.8	261	80.3
Hispanic	19	5.7	20	6.1
Native American	5	1.5	6	1.8
Other (More than one ethnicity indicated)	12	3.6	11	3.4
White	2	.6	1	.3
Question not included on Survey (1988-1990)	27	7.8	26	8.0
Gender				
Female	227	69.0	232	70.9
Male	102	31.0	95	29.1
Academic Rank				
Sophomore	3	.9	2	.6
Junior	43	13.1	52	15.9
Senior	278	84.5	260	79.5
Other (Fifth year senior or graduated)	4	1.2	11	3.4

Descriptive Statistics of Dependent Variables

Interest. Using a six-point Likert-type scale, Interest is gauged by one item assessing how much participation in the program stimulated desire to pursue graduate study. The mean of this item was 5.11 and standard deviation was 1.11.

Program participation outcome value. Using a six-point Likert-type scale, Outcome Value is measured by one questionnaire item related to how much value students attribute to the general costs and benefits of participating in the program. The mean of this item was 5.65 and standard deviation was .682.

Knowledge of graduate school and research processes. Using a four-point Likert-type scale, the Knowledge variable is based on participants' perception of how much their knowledge of the processes involved in graduate school and research increased as a result of program participation. It is measured by one questionnaire item, with a mean of 3.72 and standard deviation of .529.

Estimation and Evaluation of the Measurement Models

Quality of faculty preceptor relationship. Quality of the faculty preceptor relationship was comprised of three items related to the following relationship qualities: 1) overall quality 2) productive and 3) positive and satisfying. The factor loadings, .95, .95, and .98 respectively, were all significant at $p < .001$ level. The squared multiple correlations (R-squares) were all high at .910, .897, and .965 respectively, meaning that the quality of faculty preceptor relationship factor explained just under 90% of the variance associated with the second indicator, productivity of the faculty preceptor relationship. Sample two also demonstrated good fit, with all factor loadings significant at $p < .001$ level and all R-squares in an acceptable range from .835 -.966.

Program satisfaction. Program satisfaction was comprised of three questionnaire items related to the following: 1) satisfaction with decision to participate in program 2) overall impression of program 3) and whether they would recommend the program to others. Factor loadings of the confirmatory factor analysis, .884, .946, and .905, were significant at the .001 level for all items. The explained variances (R-squares) were .78, .90, and .82 respectively. Similarly, the loadings for sample two were all significant at the .001 level and the R-squares, .776 - .966, were all in the acceptable range. Table 2 contains the unstandardized estimates, standard error, standardized estimates, and R-squares for the latent variables for sample one and Table 3 contains the same information for sample two.

Table 2

Sample One Factor Loadings and R-squares for the Measurement Model

Measure	Unstandardized loadings	SE	Standardized loadings*	R^2
Faculty Preceptor Relationship				
Overall				
Relationship	1.00 [a]	--	.954	.910
Positive and				
Satisfying	.992	.010	.947	.897
Productive	1.030	.010	.982	.965
Program Satisfaction				
Pleased				
Participated	1.00 [a]	--	.884	.781
Overall				
Program	1.071	.046	.946	.896
Recommend to				
Others	1.023	.041	.905	.818

[a] Not estimated
*All estimates were significant at $p < .05$

Table 3

Sample Two Factor Loadings and R-squares for the Measurement Model

Measure	Unstandardized loadings	SE	Standardized loadings*	R^2
Faculty Preceptor Relationship				
Overall				
Relationship	1.00[a]	--	.914	.835
Positive and				
Satisfying	1.056	.017	.983	.966
Productive	1.030	.014	.965	.932
Program Satisfaction				
Pleased				
Participated	1.00[a]	--	.920	.847
Overall				
Program	.957	.046	.881	.776
Recommend to				
Others	.972	.054	.894	.799

[a] Not estimated
*All estimates were significant at $p < .05$

Fit indices for latent variables. The two factor CFA for faculty preceptor relationship and program satisfaction indicated good fit, χ^2 (4, N= 336) = 1.393, p = .84, CFI = 1.00, TLI =1.00, RMSEA = .00, and SRMR = .02 for sample one and χ^2 (4, N= 336) = 7.311, p = .12, CFI = 1.00, TLI =1.00, RMSEA = .05, and SRMR = .03 for sample two, indicating that the items were salient representations of the underlying constructs of faculty preceptor relationship and program satisfaction. The fit indices of the CFA for both samples are summarized in Table 4.

Table 4

Fit Indices for the Two Factor Measurement Model

Sample	χ^2	df	p	CFI	TLI	RMSEA	SRMR
Sample							
One	1.393	4	.84	1.00	1.00	.00	.02
Sample							
Two	7.311	4	.12	1.00	1.00	.05	.03

Estimation of the Initial Full Structural Model

Results of the research questions are outlined below:

1. How well does the proposed model represent the interrelationships of program outcomes?

The hypothesized model had good fit to the data for sample one; χ^2 (14, N= 319) = 17.47, p = .23, CFI = 1.00, TLI =1.00, RMSEA = .03, and SRMR = .04. Additionally, of the eight direct paths tested, six were significant at $p < .05$ level (See Figure 5). The two direct paths that were not significant originated at faculty preceptor relationship and went to the following: 1) Knowledge and 2) Outcome Value. The standard errors were all reasonable, ranging from .008 to .08. Thus, the overall fit was acceptable, with additional analyses needed to clarify the effects of faculty preceptor relationship.

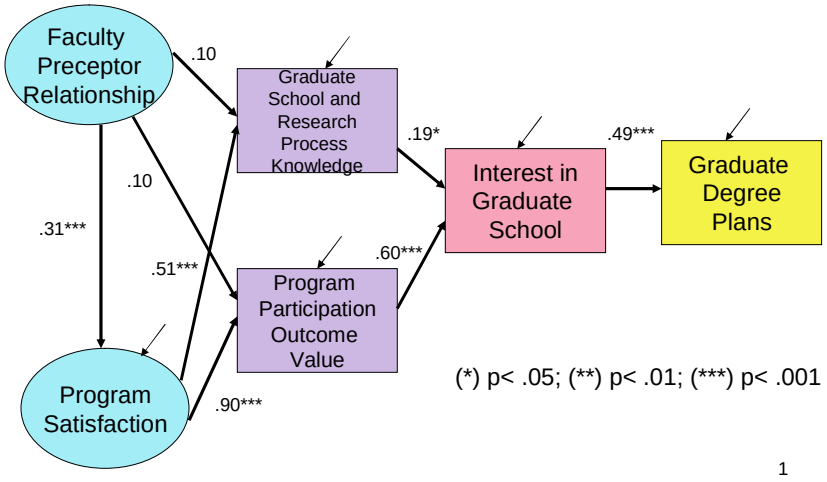


Figure 5. Results of the structural model test of the association between program participation and plans to pursue graduate study with sample one χ^2 (14, N= 319) = 17.47, p = .23 CFI = 1.00, TLI = 1.00, RMSEA = .03, SRMR = .04.

Results of the direct and indirect effects are now presented.

Hypothesis 1: The proposed model adequately represents the interrelationships of program outcomes and participants' plans to pursue graduate study.

A. Interest in graduate study will have a direct effect on educational plans for graduate study.

- The results supported this hypothesis, showing that interest in graduate study had a positive and significant direct effect on participants' educational plans for graduate study ($\beta = .491$, $p < .001$).

B1. Knowledge will have a direct effect on interest in graduate study.

-Knowledge had a positive and significant direct effect on interest in graduate study ($\beta = .20$, $p < .05$).

B2. Knowledge will have an indirect effect on plans for a graduate degree, through Interest.

- Knowledge had a positive and significant indirect effect on plans for a graduate degree, through Interest ($\beta = .10$, $p < .05$).

C1. Outcome Value will have a direct effect on interest in graduate study.

- Outcome Value had a positive and significant indirect effect on interest in graduate study ($\beta = .58$, $p < .001$).

C2. Outcome Value will have an indirect effect on plans for a graduate degree, through Interest.

-Outcome Value had a positive and significant indirect effect on plans for a graduate degree, through Interest ($\beta = .29$, $p < .01$).

D1. Faculty preceptor relationship will have a direct effect on Knowledge.

- Faculty preceptor relationship did not have a significant direct effect on Knowledge ($\beta = .10$, $p > .05$).

D2. Faculty preceptor relationship will have a direct effect on program participation outcome value.

- Faculty preceptor relationship did not have a significant direct effect on Outcome Value ($\beta = .10$, $p > .05$).

D3. Faculty preceptor relationship will have an indirect effect on plans for a graduate degree, through Knowledge and Interest.

- Faculty preceptor relationship did not have a significant effect on plans for a graduate degree, through Knowledge and Interest ($\beta = .01$, $p > .05$).

D4. Faculty preceptor relationship will have an indirect effect on plans for a graduate degree, through Outcome and Interest.

- Faculty preceptor relationship did not have a significant effect on plans for a graduate degree, through Outcome Value and Interest ($\beta = .03$, $p > .05$).

E1. Program satisfaction will have a direct effect on Knowledge.

- Program satisfaction had a positive and significant direct effect on Knowledge ($\beta = .52$, $p < .001$).

E2. Program satisfaction will have a direct effect on program participation outcome value.

- Program satisfaction had a positive and significant direct effect on Outcome ($\beta = .90$, $p < .001$).

E3. Program satisfaction will have an indirect effect on plans for a graduate degree, through Knowledge and Interest.

- Program satisfaction had a positive and significant indirect effect on plans for a graduate degree, through Knowledge and Interest ($\beta = .05$, $p < .05$).

E4. Program satisfaction will have an indirect effect on plans for a graduate degree, through Outcome and Interest.

- Program satisfaction had a positive and significant indirect effect on plans for a graduate degree, through Outcome and Interest ($\beta = .26$, $p < .001$)

The parameter estimates for the full structural model are provided in Table 5.

Table 5

Parameter Estimates, Standard Errors, Standardized Estimates, and P-values for Initial Model

Path	Unstandardized estimate	SE	Standardized estimate	p
Faculty Preceptor Relationship -Program Satisfaction	.194	.050	.311	***
Faculty Preceptor Relationship – Knowledge	.037	.033	.096	n.s.
Faculty Preceptor Relationship – Outcome Value	.087	.049	.098	n.s.
Program Satisfaction – Knowledge	.316	.066	.513	***
Program Satisfaction – Outcome Value	1.277	.230	.897	***
Knowledge – Interest	.219	.090	.185	*
Outcome Value - Interest	.305	.054	.596	***
Interest – Graduate Degree Plans	.398	.079	.491	***

(*) p< .05. (**) p< .01. (***) p< .00. n.s.- not significant.

In addition to examining direct effects, several indirect effects were also tested. All of the indirect effects tested were significant at the $p < .05$ level, with the exception of the two indirect effects that included the path from faculty preceptor relationship to Knowledge and faculty preceptor relationship to Outcome Value. Tables 6 - 11 summarize the results of the indirect effects tested.

Table 6

Table of Indirect Effects from Faculty Preceptor Relationship to Graduate Degree Plans Through All Paths

	Estimates	S.E.	Est./S.E.	Std	StdYX
Total indirect	0.049	0.013	3.711	0.153	0.133
Specific indirect by path					
Grad degree plans Interest Outcome value Fac precept	0.010	0.006	1.649	0.032	0.028
Grad degree plans Interest Knowledge Fac precept	0.003	0.003	1.045	0.011	0.009
Grad degree plans Interest Outcome value Program sat Fac precept	0.029	0.009	3.116	0.092	0.080
Grad degree plans Interest Knowledge Prog sat Fac precept	0.006	0.003	2.095	0.018	0.016

Table 7

Table of Indirect Effects from Faculty Preceptor Relationship to Interest in Graduate Study Through All Paths

Path	Estimates	S.E.	Est./S.E.	Std	StdYX
Total indirect	0.120	0.026	4.557	0.376	0.268
Interest Outcome value Fac precept	0.025	0.015	1.755	0.080	0.057
Interest Knowledge Fac precept	0.008	0.008	1.074	0.026	0.019
Interest Outcome value Program sat Fac precept	0.072	0.021	3.509	0.226	0.161
Interest Knowledge Program sat Fac precept	0.014	0.007	2.054	0.044	0.032

Table 8

Table of Indirect Effects from Program Satisfaction to Graduate Degree Plans Through All Paths

Path	Estimates	S.E.	Est./S.E.	Std	StdYX
Total indirect	0.185	0.045	4.118	0.355	0.308
Grad degree plans Interest Outcome value Program sat	0.154	0.041	3.764	0.297	0.258
Grad degree plans Interest Knowledge Program sat	0.030	0.014	2.220	0.058	0.050

Table 9

Table of Indirect Effects from Program Satisfaction to Interest in Graduate Study Through All Paths

	Estimates	S.E.	Est./S.E.	Std	StdYX
Total indirect	0.456	0.073	6.203	0.875	0.623
Specific indirect by path					
Interest Outcome value Program sat	0.381	0.069	5.540	0.732	0.521
Interest Knowledge Program sat	0.075	0.033	2.261	0.143	0.102

Table 10

Table of Indirect Effects from Outcome Value to Graduate Degree Plans

Path	Estimates	S.E.	Est./S.E.	Std	StdYX
Grad degree plans Interest Outcome value	0.117	0.031	3.791	0.117	0.287

Table 11

Table of Indirect Effects from Knowledge to Graduate Degree Plans
Through All Paths

	Estimates	S.E.	Est./S.E.	Std	StdYX
Grad degree plans					
Interest					
Knowledge	0.092	0.039	2.381	0.092	0.097

2. To what extent does the proposed model predict participants' post-program educational plans to pursue graduate study?

-The R-square was .24, indicating that the model predicted 24% of the variance in participants' educational plans to pursue graduate study.

Model Exploration

Based on the two nonsignificant paths produced by the initial model, model exploration began by deleting the two nonsignificant paths: faculty preceptor relationship to Outcome Value and faculty preceptor to Knowledge. Results of the test of the modified model were as follows: χ^2 (14, N= 319) = 18.82, p = .17; CFI = 1.00; TLI = 1.00; RMSEA = .03; SRMR = .05. The modified model resulted in an R-Square value of .25 compared to .24 in the initial model. It is important to note that it was not statistically possible to conduct chi-square difference testing between the initial model and the nested model because the chi-square values and the degrees of freedom calculated by WLSMV estimation in Mplus cannot be used for difference tests. In light of the minimal differences between the results, the researcher concluded that the fit of the model was not significantly better with the modifications. Moreover, based on the initial model's goodness of fit and the lack of evidence suggesting feasible respecification, further exploration was not conducted.

Cross-Validation

Given the theoretical and practical importance of the faculty preceptor relationship, the researcher chose to test the withheld data sample with the initial model, rather than the modified model, despite the fact that the modified model was more parsimonious. The decision to use the initial model provides an additional opportunity to test the effects of faculty preceptor relationship, which based on theory and implications of past research, should be significant. Sample two was used to test the initial model and to determine if findings would confirm or disaffirm the results produced by sample one. Results of research question one show that the initial model tested with sample two had good fit to the data. The chi-square statistic was nonsignificant at χ^2 (15, N = 317) = 19.78, p = .18. The fit indices

were all acceptable with CFI = 1.00, TLI = 1.00, RMSEA = .03 and SRMR= .04. Table 12 contains the results of the test of the initial model with sample one and sample two and the results of the cross- validation. It is important to note that when WLSMV estimation is used with Mplus the degrees of freedom are estimated based on a formula provided in the Mplus Technical Appendices. Therefore, the degrees of freedom was 14 for the initial model and 14 for the modified model, even though two fewer paths were estimated in the modified model. Additionally, the degrees of freedom increased when the initial model was tested with sample two, although the number of paths estimated did not change. The results of the three tests conducted are summarized in Table 12.

Table 12

Results of the Initial, Revised, and Cross-Validation Tests

Model	χ^2	df	P	CFI	TLI	RMSEA	SRMR	R^2
Initial model with								
sample one	17.47	14	.23	1.00	1.00	.03	.04	.24
Revised model with								
sample one	18.82	14	.17	1.00	1.00	.03	.05	.25
Initial model with								
sample two	19.78	15	.18	1.00	1.00	.03	.04	.22

Figure six contains the regression estimates obtained from the test of the initial model using sample two. All of the direct paths, with the exception of one, were significant at the $p < .05$ level. Faculty preceptor mentor relationship failed to be directly related to Outcome Value. Unexpectedly, one indirect path that did not include faculty preceptor mentor relationship and Outcome Value was also nonsignificant, that being faculty preceptor mentor relationship to plans for graduate degree through better understanding of graduate school and research. Findings for research question two indicate that the model had good predictive power for sample two with R-square = .22.

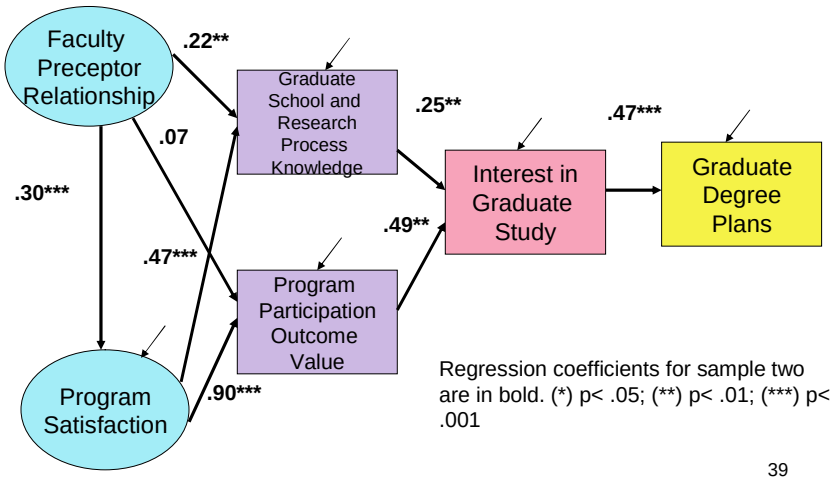


Figure 6. Initial structural model with standardized coefficients for sample two, χ^2 (15, N= 317) = 19.78, p=.18, CFI= 1.00, TLI= 1.00, RMSEA= .03, SRMR= .04.

Summary of Results

The proposed model had good fit with the data in explaining the relationships among SPGRE program outcomes. In sample one the model predicted 24% of the variance in students' plans to obtain a graduate degree, and in sample two it predicted 22%. The results indicate that SCCT, as modeled in the study, provides a feasible explanation of the interrelationship of program outcomes. The first test of sample one indicated that all but two of the hypothesized paths of the initial model were significant at $p < .05$. The second test of sample one was conducted on a nested model that deleted the two nonsignificant paths from faculty preceptor relationship to Knowledge and to Outcome Value. However, the deleted paths did not yield significant improvement in model fit. Subsequently, sample two was used to cross-validate the initial model. Similar to sample one, sample two also demonstrated good fit with the initial model. Sample two produced only one nonsignificant direct effect, from faculty preceptor relationship to Outcome Value, in contrast to two nonsignificant paths produced by sample one.

CHAPTER 5
DISCUSSION

The current study tested a SCCT based model to determine the effects among GSPP outcomes and their relationship to undergraduate students' educational plans to pursue graduate study. The results of the study support the hypothesized model, indicating the significance of faculty preceptor relationship, program satisfaction, increased Knowledge, Outcome Value, and increased interest in graduate study in influencing underrepresented students' decisions about graduate study. Chapter five discusses the implications of the findings, the limitations, and suggested directions for future research.

The initial model demonstrated good fit to the data, eliminating the need for extensive exploration. Model exploration consisted of testing one nested model, with two deleted paths. Results of the modification indicated that the model fit did not improve significantly with the deleted paths, so the cross-validation was conducted with the initial model. Therefore, the discussion chapter focuses on the initial model and the cross-validation of that model, referred to as sample one and sample two, respectively.

The faculty preceptor relationship variable was the only variable that was misspecified or showed effects of sampling variation. The relationship between faculty preceptor relationship and program satisfaction was significant, indicating that it is important to encourage faculty preceptors and students to work towards developing and maintaining a positive relationship. Because many undergraduate students may not have experience working closely with university faculty, they should be encouraged to seek advice from

program staff if or when they need assistance resolving matters with their faculty preceptors. Similarly, during separate orientation sessions, both students and preceptors should receive information that describes potential issues that may arise in student-preceptor relationships and advice on how to handle them. The activity may even be conducted as a role play where individuals can practice what they would say in a particular situation.

The effect of faculty preceptor relationship on Knowledge was inconclusive. In sample one, the relationship was nonsignificant, but in sample two it was significant at $p < .01$. A possible explanation for this finding may be related to the indicators that comprised faculty mentor relationship. While the items that were used had good fit, the factor did not include items pertaining explicitly to how much participants learned about graduate school and research from their preceptor. Additionally, it is not unusual, especially for students in the hard sciences, to work closely with postdoctoral fellows or research personnel, other than their faculty preceptor. Moreover, in addition to their faculty preceptor, program participants have numerous learning and socialization opportunities available to them through other sources such as seminars, program staff, and networking activities afforded by program participation. Walters (1997) reported that when African American and Latino students were asked what GSPP characteristics most influenced their plans to attend graduate school, one of the factors stated was receiving professional development advice from someone affiliated with the program (i.e. faculty mentor, lab mate, or program administrator), not specifically the faculty mentor. Thus, the Walters study supports the proposition that the faculty preceptor is just one of several possible sources from whom students receive advice and information during their participation in programs.

Lastly, the direct effect of faculty preceptor relationship on Outcome Value was nonsignificant in both samples. This result was unexpected. One possible explanation for the finding may relate back to the fact that the preceptor is not the sole socialization source during the program, and that other variables contribute to participants' Outcome Value perceptions. One encouraging implication of this finding is that in the unfortunate occurrence of a poor student-faculty preceptor relationship, it is still possible for the student to develop strong outcome values through other program experiences.

There were several significant indirect effects related to faculty preceptor relationship. The association between faculty preceptor relationship and Knowledge was significant when moderated by program satisfaction. This association held for both sample one and sample two. The fact that the relationship is mediated by program satisfaction may imply that students with high program satisfaction levels are more open to increasing their knowledge about graduate school and research. It is also possible that the students with high satisfaction seek out opportunities to learn more. The association between faculty preceptor relationship and Outcome Value was also significant when moderated by program satisfaction. This finding was not surprising given the significant direct effect of faculty preceptor relationship on Outcome Value. The direct effect between program satisfaction and 1) Knowledge and 2) Outcome Value signifies the importance of students having a positive experience, being pleased with their decision to participate in the program, and valuing the program experience highly enough to recommend the program to others. Program satisfaction has considerable effects on each of the two variables it influences directly. Given the magnitude of its influence, it may be informative to conduct additional analyses on the program satisfaction variable in order to identify specific program experiences that are

associated with program satisfaction. The importance of participant satisfaction was also supported by Grimmett, Bliss, Davis, and Ray (1988), who contend that satisfaction ratings are indicative of the adequacy and appropriateness of the GSPP intervention. Additionally, the positive influence of increased Knowledge of graduate school and research on increased Interest in graduate study was confirmed. This finding is consistent with previous studies in which students indicated that being in the research environment and conducting research demystified the research process and enabled students to develop more positive perceptions of research and graduate study (Frierson & Zulli, 2002; Smith, Lewis, and Frierson, 2006). Additionally, in a study of undergraduate students who planned to pursue graduate study within a year, Robinson & Golde (1999) reported that those with the most "savy" understanding of the process related to selecting a graduate program and applying to graduate school were more likely to enter graduate programs than their counterparts with less knowledge. Therefore, it is significant to note that in the current study, participants' increased knowledge is related to increased interest in graduate study. Perhaps this finding indicates that the knowledge participants' gain addresses critical issues that have a direct bearing on their interest in graduate study. Similarly, the influence of Outcome Value on graduate school interest was also significant, indicating the importance of programs helping participants to understand how what they are now doing will benefit them in the future. Along the same lines, it is important for participants to see value and worth in the outcomes that they expect to gain from program participation. Therefore, if students are required to take a GRE preparation in the program they should understand the importance of GRE scores to the graduate school admission process, or if students are required to write a final paper

related to their research project, they should understand that they can later use the paper as a writing sample or perhaps submit it for presentation at a professional conference.

The last relationship tested was the effect of Interest on plans to pursue graduate study. The strong relationship between these variables is important because increased Interest does not necessarily lead to plans to pursue graduate study. It would have been possible for participants to indicate that their interest in graduate school increased as a result of the program but still not reach the point where they have a goal to pursue graduate study. Indeed, many factors can mitigate the transition from interest to goal pursuit, particularly among underrepresented students. For example, financial concerns, uncertainty about the benefits of graduate study, lack of advisement, and many other factors have been cited as reasons students choose not to pursue graduate study. It is reassuring to see the significant association between students' interest level and plans to pursue graduate study. The finding may imply that these students do not perceive barriers or that they believe that they will be able to overcome them and achieve their goal of going to graduate school.

Limitations

While this exploratory study found significant effects of the relationships tested, interpretation of the findings is subject to limitations. First, as with any model testing, it is important to acknowledge that equivalent and alternative models may also provide good fit to the data. Thus, there might be models other than the model supported in the present study that reproduce the data. This limitation applies to all test of model of fit and does not distract from the importance of the findings. Secondly, advantages of using the SPGRE Questionnaire as a data source include its consistency over the course of the program's existence, the high completion rate, and the applicability of the questions asked to the current

study. However, because the questionnaire was not developed specifically for the current line of research, specification of variables was limited to data that had been collected.

Suggested Future Studies

While the findings of the current study are informative, a strong need remains for additional research related to modeling the effects of participation in GSPP. The work of the present study can be extended by testing SCCT based models for equality across groups. Also known as multi-group analysis, this procedure tests for significant differences within samples based on characteristics such as gender, participants' field of study, or participant's type of home institution (Historically Black College or University or not). Multi-group analyses include tests for differences in overall model fit and differences on individual paths, allowing the researcher to assess the applicability of the model to subgroups within the sample.

Another area appropriate for future research is to use the current model as a core from which more elaborate models are built. Two specific types of expansion models that should be explored include one that adds personal and academic factors to the program variables and one that employs the full SCCT model. Since students' ultimate decisions are not based on the program alone, adding variables such as grade point average and perception of family support may provide a more comprehensive perspective of the factors associated with students' graduate degree plans. Concerning the full SCCT model, the current study specified participants' plans to pursue graduate study as the major outcome variable of interest, while the full SCCT model specifies career or educational action via performance or persistence as the major outcome variable. Thus, a test of the full model would be expanded to specify the major outcome variable as matriculation in graduate study or degree attainment. Given

participants' high graduate school matriculation and completion rates, testing the model's ability to predict enrollment in doctoral degree programs and completion of the PhD would be logical and important next steps. Moreover, an extended model could test the following additional SCCT variables that were not in the current model: 1) the influence of contextual influences (environmental supports and barriers) on goals 2) the influence of contextual influences on actions and 3) the influence of person inputs (gender, academic rank, etc.) and background contextual affordances on the learning experience. It will be interesting to test the relationships of the additional SCCT variables and to determine if they have significant effects. Lastly, more in-depth examination of the variables tested in the current study may provide meaningful findings. For instance, the current study supported the relationship between Knowledge and interest in graduate study. However, the knowledge variable was measured as a general concept, without reference to knowledge of particular aspects of graduate study or research. Including greater levels of specificity for the program outcomes may further increase understanding of the contribution of various program factors.

Implications

The current study has implications for research related to GSPPs and for the design and implementation of such interventions. In general, the findings provide insight into areas that programs should target and where interventions should focus. One important contribution is the confirmation of SCCT as a viable theory for GSPP research and program development. SCCT is particularly adept for intervention research and design because of its focus on learning experiences and their subsequent outcomes. Thus, SCCT should be given strong consideration as a potential framework for GSPP research. In addition to expanding the theoretical frameworks applied to GSPPs, the current study also broadens the statistical

techniques employed by using SEM. SEM permits examination of complex relationships among variables, including the use of latent constructs and the testing of multiple dependent variables from an "explanatory" perspective (Mueller, 1997). Additionally, determining the strength of the association between tested program outcomes and students' plans to pursue graduate study, as well as specification of how the outcomes relate to each other, is significant. Understanding the strength of the associations and interrelationships may assist program developers and managers when trying to allocate limited resources by allowing them to devote greater resources to the program factors that have the greatest positive influences. One final contribution of this study is that it is the only study identified that examines GSPP participants' interest in graduate study based specifically on factors related to the GSPP program experience.

Conclusion

Extant literature on GSPPs typically emphasizes positive student outcomes that are associated with program participation. However, there is little understanding of how or why the results are achieved. This study examined selected GSPP outcomes in order to broaden our understanding of how the factors are connected with an important goal, students' plans to pursue graduate studies. The findings provide quantitative data regarding the effects among variables. Significantly, no previous studies were identified which modeled GSPP participants' plans for a graduate degree, based specifically on outcomes related to the GSPP experience. Thus, indicating a need to investigate this important missing link. Overall, the findings support the following direct relationships:

a) plans for graduate study are directly influenced by increased interest in graduate study

b) increased interest in graduate study is directly influenced by the outcome value that students ascribe to program participation and by increased knowledge about graduate school

c) outcome value of program participation is influenced by program satisfaction

e) knowledge of graduate school and research is directly influenced by program satisfaction and faculty preceptor relationship

f) program satisfaction is directly influenced by faculty preceptor relationship

Moreover, the effect of faculty preceptor relationship on knowledge of graduate school and research process was significant with the second sample, but nonsignificant in the first sample, while the effect of faculty preceptor relationship on outcome value of program participation was not supported.

The findings have significance for program delivery in that the information can be applied to training and orienting staff, program improvement, and program development. For example, based on the findings, program mangers should realize the importance of program satisfaction and develop means to both assess and promote student satisfaction. Finally, the study may have implications for future research related to GSPPs. In order to expand research in this area and to understand better the program results that we observe, researchers should consider employing modeling. Modeling would not be a replacement for other research methods, but rather an additional tool to use when appropriate. Consequently, the findings indicate that underrepresented students' decisions about graduate school appear to be influenced in the following ways: 1) through student-faculty preceptor relationships that students perceive as positive and productive 2) through program satisfaction, or providing an overall program experience that students perceive as relevant and effective 3) by providing

an experience with outcome values that students see as worthwhile 4) by providing activities that increase students' knowledge of graduate school and research and 5) by increased interest in graduate study.

GSPPs are an appropriate context in which to offer services that promote achievement of the outcomes found to be correlated with students' plans to pursue graduate study. Thus, GSPPs have the potential to enhance underepresented students' motivation for, interest in, and preparation for graduate study. However, sustainability of the programs will rely increasingly on their ability to document effectiveness. While extant literature reports positive outcomes, it is equally important to establish empirical links between outcomes and program participation. Thus, efforts to increase our understanding of how and why the programs succeed are as important as the programs themselves.

APPENDIX A

2000 UNC-CH SUMMER PRE-GRADUATE RESEARCH PROGRAM EVALUATION QUESTIONNAIRE

The purpose of this questionnaire is to obtain your candid assessment of various aspects of the UNC-CH SPGRE Program. Please respond to all appropriate items. Thank you for your cooperation.

1. Gender: ___Female ___Male

2. Ethnicity: ___African American or of African Descent ___American Indian ___Hispanic/Latino (please indicate _____) ___European American/Caucasian ___Pacific Islander or Asian(please indicate _____) ___Other (please indicate _____)

3. Type of School Currently Attending:
___ Historically Black
___ Historically Native American
___ Historically or Predominantly White

4. Academic Rank as of fall 2000:
___Junior ___Senior ___Other (please explain below)

5. Please list your college major(s) in the space below:

6. Please indicate the field and name of department or location in which you participated in research this summer:

a. Discipline or field_____

b. Department name or location_____

c. Where you in the MURAP component? ___Yes ___No

7. How well did SPGRE meet your expectations?

Exceeded expectations	Met expectations	Undecided	Did not meet expectations
4	3	2	1

7a. If SPGRE did not meet your expectations, please briefly describe the expectations you had.

8. Given your experiences in SPGRE, are you pleased that you participated?

Yes, Definitely | Yes, Somewhat | Unsure | No, Definitely

4 | 3 | 2 | 1

9. After participating in the program, do you feel that you have a better understanding of what is involved in graduate studies and research?

Yes, Definitely | Yes, Somewhat | Not Sure | No, Definitely

4 | 3 | 2 | 1

10. Please list below any aspects of the program that you found particularly useful (please use the back if needed).

11. Please list below, any aspects about the program that you found particularly enjoyable.

Using the scale below, for each item please circle the number in the right margin that corresponds to your response.

Very Favorable | Favorable | Somewhat Favorable | Somewhat Unfavorable | Unfavorable | Very Unfavorable

6 | 5 | 4 | 3 | 2 | 1

12. Your overall impression regarding the following:

a. The total program 6 5 4 3 2 1
b. The on-campus living arrangements 6 5 4 3 2 1 NA
c. The working conditions and facilities for research 6 5 4 3 2 1
d. The stipend 6 5 4 3 2 1
e. Relationship with your mentor 6 5 4 3 2 1
f. Relationships with other students and personnel in your lab or research setting. 6 5 4 3 2 1 NA
g. Your involvement in your mentor's research activity 6 5 4 3 2 1 NA
h. Your effort regarding your specific research activity or project 6 5 4 3 2 1
i. The Graduate School administration and staff 6 5 4 3 2 1
j. Fellow students in the program 6 5 4 3 2 1
k. The amount of information learned this summer 6 5 4 3 2 1
l. Your involvement with your mentor 6 5 4 3 2 1

Using the scale below, for each item please circle the number in the right margin that corresponds to your response.

Strongly Agree | Agree | Agree Somewhat | Disagree Somewhat | Disagree | Strongly Disagree

6 | 5 | 4 | 3 | 2 | 1

13. The program was worth my time and effort. 6 5 4 3 2 1

14. The program stimulated my desire to pursue graduate

studies. 6 5 4 3 2 1

15. The program stimulated me to pursue graduate studies in the general area in which I worked this summer. 6 5 4 3 2 1

16. The program stimulated me to pursue graduate studies, but not necessarily in the area I worked this summer. 6 5 4 3 2 1
(a. Please list the area if applicable_____)

17. The program stimulated an interest in my pursuing a research career. 6 5 4 3 2 1

18. The on-campus living arrangements were agreeable. 6 5 4 3 2 1 NA

19. The laboratory facilities and/or the research/working conditions were favorable for me. 6 5 4 3 2 1

20. My relationship with my mentor was productive. 6 5 4 3 2 1

21. Overall, I found my relationship with my mentor to be positive and satisfying. 6 5 4 3 2 1

22. I felt comfortable as a member of the research project with which I was associated. 6 5 4 3 2 1 NA

23. I felt that the program's administration had concern for my well-being 6 5 4 3 2 1

24. I had sufficient time to complete my research project and/or paper. 6 5 4 3 2 1 NA

25. I would recommend this program to others. 6 5 4 3 2 1

26. Please list below, up to three things you liked most about the program.

27. Please list up to three things you liked least about the program.

28. Current plans after graduation are to:
_____

29. If you are considering graduate school, will UNC-CH be one of your choices for application? ___Yes ___No
___Uncertain

If yes, please indicate below the UNC-CH programs you intend to apply.

30. In the space below, please give us your suggestions or ideas about how SPGRE can be improved for future students.

31. In the space below (and on the back if needed), please write any additional comments you wish concerning the program.

APPENDIX B

Coding Scheme for Post-baccalaureate Plans

Current plans after graduation are to:	**Initial Code**	**Recoded**
Attend graduate school	**1**	**1=Graduate Study**
Other (e.g. work, Peace Corps)	**2**	**0= No Plans for Graduate Study**
Graduate school or something else (specifically wrote grad school or …)	**3**	**0= No Plans for Graduate Study**
Professional school	**4**	**0= No Plans for Graduate Study**
Undecided	**5**	**0= No Plans for Graduate Study**
Graduate school and professional school (e.g. MD/PhD program)	**6**	**1= Graduate Study**
Missing	**9**	**9= Missing**

References

Ali, S.R., & Saunders, J.L. (2006). College expectations of rural appalachian youth: an exploration of social cognitive career theory factors. *Career Development Quarterly, 55*, 38-51.

Allexsaht-Snider, M., & Hart, L. E. (2001). 'Mathematics for all': How do we get there? *Theory into Practice, 40*, 93-101.

Anderson, J.C., & Gerbing, D.W. (1988). Structural equation modeling in practice: A review and recommended tow-step procedure. *Psychological Bulletin, 103*, 411-423.

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

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist, 44*, 1175-1184.

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

Betz, N. E., & Hackett, G. (2006). Career self-efficacy theory: Back to the future. *Journal of Career Assessment, 14*, 3-11.

Betz, N. E., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior, 23*, 329- 345.

Booker, K. C., & Frierson, H. T. (2002). *"What I did last summer:" Minority college students' perceptions of their participation in a summer research program*. Unpublished Manuscript.

Boyce, C. A. (1997). A role for graduate students. In H. T. Frierson, Jr. (Ed.), *Diversity in higher education* (Vol. 1, pp. 93-102). Greenwich, CT: JAI.

Byrne, B.N. (2001). *Structural equation modeling with AMOS.* Mahwah, NJ: Lawrence Erlbaum Associates.

Carter, D. F. (2001). *A dream deferred? Examining the degree aspirations of African American and white college students*. New York: Routledge Falmer.

Cunningham, G. B., Bruening, J., Sartore, M.L., Sagas, M., Fink, J.S. (2005). The application of social cognitive theory to sport and leisure career choices. *Journal of CareerDevelopment, 32*, 122-138

Delatte, N. (2004). Undergraduate summer research in structural engineering. *Journal of Professional Issues in Engineering Education & Practice, 130*(1), 37-43.

Eatman, T. K. (2001). Becoming a member of the research community in academe: Determinants of postbaccalaureate success for traditionally underrepresented students. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Eccles, J., Adler, T., & Meece, J. L. (1984). Sex differences in achievement: A test of alternate theories. *Journal of Personality and Social Psychology, 46*(1), 26-43.

Edwards, J. R., & Bagozzi, R. P. (2000). On the nature and direction of relationships between constructs and measures. *Psychological Methods, 5*, 155-174.

Flores, L.Y., Navarro, R.L., & Ploszaj, A. M. (2006). Testing a model of nontraditional career choice goals with Mexican American adolescent men. *Journal of Career Assessment, 14,* 214-234.

Foertsch, J.A., Alexander, B., & Penberthy, D.L. (1997). Evaluation of the UW-Madison's summer undergraduate research programs: Final Report. Madison, WI: University of Wisconsin-Madison, LEAD Center.

Fouad, N., & Guillen, A. (2006). Outcome expectations: Looking to the past and potential future. *Journal of Career Assessment, 14*, 130-142.

Frierson, H. T.,Jr. (1996a). Comparing science and non-science minority students' perceptions and satisfaction with a short-term research and mentoring program. Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY.

Frierson, H. T.,Jr. (1996b). *Perceptions of faculty preceptors in a summer research program targeted at minority undergraduate students*. Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY

Frierson, H. T.,Jr, Hargrove, B. K., & Lewis, N. R. (1994). Black summer research students' perceptions related to research mentors' race and gender. *Journal of College Student Development, 35*, 475-480.

Frierson, H. T. (2006). Summer undergraduate research programs as a route for expanding opportunities for minority students and to address the Ph.D. shortage. Unpublished manuscript.

Frierson, H. T., & Zulli, R. A. (2002). Examining the perceptions of minority undergraduate students participating in a university-based research program. In W. R. Allen, M. B. Spencer, & C. O'Conner (Eds.), *African American education: Race,*

community, inequality, and achievement: A tribute to Edgar G. Epps (pp.155-178). New York: Elsevier Science.

Gainor, K. A., & Lent, R. W. (1998). Social cognitive expectations and racial identity attitudes in predicting the math choice intentions of black college students. *Journal of Counseling Psychology, 45*, 403-413.

Government Accountability Office. (2006). Science, Technology, Engineering, and Mathematics trends and the role of federal programs. (GAO-060702T). Washington, DC: U.S. Government Printing Office.

Goyette, K. A., Mullen, A. L., & Soares, J. A. (2003). Who goes to graduate school? Social and academic correlates of educational continuation after college. *Sociology of Education, 76*(2), pp.143-169.

Grimmett, M. A. S., Bliss, J. R., Davis, D., & Ray, L. (1998). Assessing federal TRIO McNair program participants' expectations and satisfaction with projects. *Journal of Negro Education, 67*(4), 404.

Hackett,G., & Betz, N.E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education, 20*, 261-273.

Hamrick, F.A., & Stage, F.K. (2004). High minority enrollment, high school-lunch rates: Predisposition to college. *Review of Higher Education, 21*, 343-357.

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

Hidi, S., & Harackiewicz, J.M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. Review of Educational Research.

Hoffer, T.B., Welch, Jr., V., Webber, K.,Williams, B., Lisek, M., Hess, D. Loew, and I. Guzman-Barron. (2006). *Doctorate Recipients from United States Universities: Summary Report 2005.* Chicago: National Opinion Research Center.

Hoyle, Rick H. (1995). The structural equation modeling approach: Basic concepts and fundamental issues. In R.H. Hoyle (Ed.), *Structural Equation Modeling: Concepts, Issues, and Applications* (pp. 1-15). Thousand Oaks, CA: Sage Publications.

Hoyte, R. M., & Collett, J. (1993). "I can do it": Minority undergraduate science experiences and the professional career choice. In J. Gainen, & R. Boice (Eds.), *Building a diverse faculty* (pp. 81-90). San Francisco: Jossey-Bass.

Hu, L., & Bentler, P.M. (1999). Cutoff criteria for fit indices in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling, 6(1), 1-55.*

Irving, M. A., & Hudley, C. (2005). Cultural mistrust, academic outcome expectations, and outcome value among African American males. *Urban Education,* 40, 476-496.

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.

Kao, G., & Tienda, M. (1998). Educational aspirations of minority youth. *American Journal of Education, 106*, 349.

Kardash, C. M. (2000). Evaluation of an undergraduate research experience: Perceptions of undergraduate interns and their faculty mentors. *Journal of Educational Psychology, 92*(1), 191-201.

Kazis, R., Vargas, J., & Hoffman, N. (Eds.). (2004). *Double the numbers: Increasing postsecondary credentials for underrepresented youth*. Cambridge: Harvard Education Press.

Kerckhoff, A. C. (1984). The current state of social mobility research. *Sociological Quarterly, 25*, 139-153.

Kerka, S. (2003). Career development of diverse populations. *ERIC digest*.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York: The Guilford Press.

Kline, R.B. (Ed.). (2005). Principles and practice of structural equation modeling. New York: The Guilford Press.

Ladson-Billings, G. (1997). It doesn't add up: African American students' mathematics achievement. *Journal for Research in Mathematics Education, 28*, 697-708.

Leeman, J., Goeppinger, J., Funk, S., & Roland, E. J. (2003). An enriched researchexperience for minority undergraduates--A step toward increasing the number of minority nurse researchers. *Nursing Outlook, 51*(1) 20-24.

Lent, R. W. (2006). On conceptualizing and assessing social cognitive constructs in career research: A measurement guide. *Journal of Career Assessment, 14*, 12-35.

Lent, R. W., & Brown, S. D. (2006). On conceptualizing and assessing social cognitive constructs in career research: A measurement guide. *Journal of Career Assessment,14*, 12-35.

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

Lent, R. W., Brown, S. D., Nota, L., & Soresi, S. (2003). Testing social cognitive interest and choice hypotheses across Holland types in Italian high school students. *Journal of Vocational Behavior, 62,* 101-118.

Lent, R. W., Brown, S. D., Sheu, H. B., Schmidt, J., Brenner, B. R., & Gloster, C. S., et al. (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,* 84-92.

Lent, R. W., Brown, S. D., Schmidt, J., Brenner, B., Lyons, H., & Treistman, D. (2003). Relation of contextual supports and barriers to choice behavior in engineering majors: Test of alternative social cognitive models. *Journal of Counseling Psychology, 50,* 458-465.

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, N., & Frierson, H.T. (2006, February). Increasing access: Students' attitudes toward graduate school and research careers following participation in a summer program. Paper presented at the annual meeting of the Southeast Evaluation Association, Tallahassee, FL.

Maddox, A.B., & Smith-Maddox, R.P. Developing graduate school awareness for engineering and science: A model. *The Journal of Negro Education, 59,* 479-490.

Mahaffy, K. A., & Ward, S. K. (2002). The gendering of adolescents' childbearing and educational plans: Reciprocal effects and the influence of social context. *Sex Roles, 46,* 403- 417.

Malcom, S. M., Chubin, D. E., & Jesse, J. (2004). Standing our ground: A Guidebook for STEM educators in the post-Michigan era. Washington, D.C., American Association for the Advancement of Science, National Action Council for Minorities in Engineering.

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

Mau, W.C., & Bikos, L. H. (2000). Educational and vocational aspirations of minority and female students: A longitudinal study. *Journal of Counseling & Development, 78,* 186-194.

McHenry, W. (1997). Mentoring as a tool for increasing minority student participation in science, mathematics, engineering, and technology undergraduate and graduate programs.

McWhirter, E. H., Hackett, G., & Bandalos, D. L. (1998). A causal model of the educational plans and career expectations of Mexican American high school girls. *Journal of Counseling Psychology, 45*, 166-181.

Meece, J., Wigfield, A., & Eccles, J.S. (1990). Predictors of math anxiety and its consequences for young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology, 82*, 60-70.

Mervis, J. (2006). NIH told to get serious about giving minorities a hand. *Science, 311, 328*-329.

Mueller, R. (1997). Structural equation modeling: Back to basics. *Structural Equation Modeling*, 4, 353-369.

National Center for Education Statistics (2004). Digest of education statistics. Retrieved May 1, 2005, from http://nces.ed.gov/programs/digest/d03/tables/dt209.asp.

National Center for Education Statistics (2005). Digest of education statistics. Retrieved March 4, 2006, from http://nces.ed.gov/programs/digest/d05/ch_3.asp.

Nnadozie, E., Ishiyama, J., & Chon, J. (2001). Undergraduate research internships and graduate school success. *Journal of College Student Development, 42*, 145-156.

National Science Foundation (2000). The cultural context of educational evaluation: The role of minority evaluation professionals. Arlington,VA: National Science Foundation.

National Science Foundation (2006). Science and Engineering Statistics. Retrieved October 7, 2006, from http://www.nsf.gov/statistics/wmpd/tables/tabf-5.xls.

Pascarella, E. T., & Terenzini, P. T. (1991). *How college affects students*. San Francisco: Jossey-Bass.

Pascarella, E. T., Wolniak, G. C., Pierson, C. T., & Flowers, L. A. (2004). The role of race in the development of plans for a graduate degree. *Review of Higher Education, 27*(3), 299-320.

Riggins, T. A., & Frierson, H. T.,Jr. (1996). *Gender effects on minority students' perceptions of satisfaction with a summer research program*. New York

Robinson, S., & Golde, C. M. (1999). Waffling and flailing: Undergraduates in pursuit of a Ph.D. Paper presented at the annual meeting of the Association for the Study of Higher Education, San Antonio, TX.

Sharp, L., Kleiner, B., & Frechtling, J. (2000). *A Description and analysis of best practice findings of programs promoting participation of underrepresented undergraduate students in science, mathematics, engineering, and technology fields*. Westat.

Simpson, M. (2003). Exploring the Academic and Social Transition Experiences of Ethnic Minority Graduate Students. Unpublished Doctoral Dissertation, Virginia Polytechnic Institute and State University.

Smith, T., Lewis, N., & Frierson, H. T. (2006). Closing the gap: Related effects of participation in a short term research program on African American undergraduates' perceptions of research and graduate school. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Snyder, T. D. (2004). *Mini-digest of education statistics 2003* No. NCES 2005-017). Jessup, MD: U.S. Department of Education.

Stolzenberg, R. M. (1994). Educational continuation by college graduates. *American Journal of Sociology, 99*, 1042-1077.

Thomas, E. P. (1994). *Taking the first steps toward graduate education: A report on the Ronald E. McNair postbaccalaureate achievement program*. New Jersey.

U.S. Department of Education, National Center for Education Statistics. (2005). *Postsecondary Institutions in the United States: Fall 2003 and Degrees and Other Awards Conferred: 2002-03* (NCES 2005-154). Retrieved April 7, 2006, from http://nces.ed.gov/fastfacts/display.asp?id=72.

Waller, B. (2006). Math interest and choice intentions of non-traditional African American college students. *Journal of Vocational Behavior, 68*, 538-547.

Walters, N. B. (1997). *Retaining aspiring scholars: Recruitment and retention of students of color in graduate and professional science degree programs.* Paper presented at the annual meeting of the Association for the Study of Higher Education.

Williams, E. G. (2005). *Academic, research, and social self-efficacy among African American pre-McNair scholar participants and African American post-McNair scholar participants.* Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University.

Wyche, J., & Frierson, H.T. (1990). Minorities at majority institutions. *Science, 249,* 989-991.