TESTING A SOCIAL COGNITIVE MODEL OF MATH/SCIENCE CAREER GOALS IN LOW-INCOME PROSPECTIVE FIRST GENERATION COLLEGE STUDENTS

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by

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The undersigned, appointed by the Dean of the Graduate School, have examined the dissertation entitled

TESTING A SOCIAL COGNITIVE MODEL OF MATH/SCIENCE CAREER GOALS IN LOW-INCOME PROSPECTIVE FIRST GENERATION COLLEGE STUDENTS

presented by Patton O. Garriott

a candidate for the degree of Doctor of Philosophy

and hereby certify that, in their opinion, it is worthy of acceptance

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DEDICATION

First, I would like to dedicate this work to my family and friends. I would especially like to thank my parents who encouraged, but never pushed and have loved unconditionally. I also thank my brothers Will and Miles for their love, support, and advice throughout the years. To my friends—thank you for keeping me grounded and filling my life with laughter.

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Finally, I dedicate this work to all the students who participated in my dissertation study and those who share their journey.

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ABSTRACT

The present study used social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994) to examine the math/science goal intentions of low-income prospective first generation college students (*N* = 308). Path analysis was used to test a model depicting relationships between contextual (i.e., academic motivation, parental support, learning experiences, proximal contextual supports) and person-cognitive (i.e., self-efficacy, outcome expectations, interests, goals) variables as hypothesized in SCCT. Results indicated that the hypothesized and alternative structural models provided poor fit to the data. Tests of mediation were statistically significant, but model fit statistics suggested mediation hypotheses should also be rejected. Furthermore, the hypothesis that proximal contextual supports would moderate the relationship between interests and goals was not supported in the present study. Implications for research and practice are discussed.

Chapter 1

Introduction

Since the Soviet Union's launch of Sputnik in 1957, the United States (U.S.) government has placed increasing emphasis on enhancing the performance and entry of students into science, technology, engineering, and math (STEM) fields (Betz, 1994; Betz & Hackett, 1985; Kuenzi, 2008). Careers in the STEM areas are associated with social mobility and have been cited as important to national economic stability and national security (National Science Board [NSB], 2006, 2007). However, while the growth of jobs available in STEM-oriented careers is projected to increase at rates significantly higher than those within the general workforce, the future U.S. workforce lacks adequate preparation to occupy these careers (NSB, 2006). Indeed, students within the U.S. K-12 school system have consistently lagged behind their international peers on indicators of math and science achievement (U.S. Department of Education, 2007a). Although recent years have seen exponential increases in funding for STEM education, there is a lack of evidence supporting the specific ingredients of programs aimed at increasing students' participation in STEM careers. For example, while $3.12 billion was allocated to STEM education in 2006, less than half of funded programs were shown to have any meaningful positive impact (U.S. Department of Education, 2007a). Research on the interaction of various individual and contextual factors in adolescents' decisions to pursue STEM careers could enhance the effectiveness of programmatic interventions for math and science education.

More studies are also needed that address the underrepresentation of specific student populations in the STEM fields. For example, approximately 4.5 million, or 24%, of students in the U.S. higher education system have parents who did not attend college, and research on this population suggests that low levels of self-efficacy, low levels of parental support, poor academic preparation, and lower social capital play a collective role in their underrepresentation in STEM careers (Bloom, 2007; Hsaio, 1992; Nelson, Englar-Carlson, Tierney, & Hau, 2006). Similarly, students of color experience discouragement from pursuing STEM disciplines and are less likely to take advanced math/science courses compared to their White peers (National Science Board, 2006). Research on the participation of underrepresented students (who tend to be students of color and of lower socioeconomic status) in STEM careers could increase the talent pool of students who pursue STEM fields (Engle & Tinto, 2008). This is important, given that students currently underrepresented in STEM disciplines will constitute rapidly increasing proportions of the college-age population within the next 15 years (Engle & Tinto, 2008; National Science Board, 2006). To address these issues, the present study will examine the relations between contextual factors and the math/science career goals of high school students underrepresented in STEM careers. Specifically, the contributions of intrinsic academic motivation, learning experiences, parental involvement, and proximal supports on person-cognitive variables will be investigated.

Contextual factors, such as academic motivation, parental involvement, and instrumental support for a given career choice, have been described as critical ingredients in adolescents' academic and career development (Bratcher, 1982; A. E. Gottfried, 1985; Lent, Brown, & Hackett, 1994; Lent et al., 2001; Otto, 2000; Roe, 1956). Existing research supports assertions that intrinsic motivation is related to academic performance (A. E. Gottfried, 1985, 1990; A. E. Gottfried, Marcoulides, A. W. Gottfried, & Oliver, 2009), parental figures influence their children's career aspirations, interests, and goals (c.f. Whiston & Keller, 2004), and that students' perceptions of supports and barriers to career options impact their interests and goals within a given career domain (Lent et al., 2003). Although the relations between individual and contextual factors and STEM career goals have been investigated in prior research (e.g., Byars-Winston & Fouad, 2008; Fouad & Smith, 1996), no studies have tested the multiple influences of academic intrinsic motivation, parental involvement (e.g., general involvement in school-related activities), and proximal supports (e.g., financial and emotional support for a child's decision to pursue a STEM career) concomitantly. However, prior research exhibits that person-level variables as well as distal and proximal environmental influences interact to affect students' learning experiences, self-efficacy, and interests in math and science careers (Byars-Winston & Fouad, 2008; Flores & O'Brien, 2002; Lent et al., 2001). Whereas distal influences exert influence prior to one's decision to pursue a given career, proximal contextual factors play key roles during the career decision-making process (Lent, Brown, & Hackett, 2000). Although several studies have examined the impact of perceived supports and barriers on college students, no studies conducted with U.S. samples have investigated how high school students' perceptions of environmental supports and barriers influence their pursuit of math and science careers.

Furthermore, while existing studies have examined the impact of perceived supports in college students, few studies have investigated how high school students' perceptions of environmental supports influence their pursuit of math and science careers. This is surprising given that many interventions to promote STEM career exploration are designed for high school students (U.S. Department of Education, 2007b). Similarly, academic motivation has been investigated in middle school as well as college students, yet has received less attention among high school students (e.g., A. E. Gottfried, 1985, 1990; Vallerand, Pelletier, Blais, Brière, Senècal, & Vallières, 1992, 1993). More research on the relationship between academic motivation and STEM career goals of high school students is needed given the documented decline in students' intrinsic academic motivation for math and science from middle to high school—a phenomenon that coincides with decreased math/science performance (A. E. Gottfried, Marcoulides, A. W., Gottfried, & Oliver, 2009; A. E. Gottfried, Marcoulides, A. W. Gottfried, Oliver, & Guerin, 2007).

Underrepresented Students in STEM

Underrepresented students in STEM careers are the population of interest in the present study. Specifically, criteria put forth by the U.S. Department of Education (2007b) to qualify for Upward Bound Math-Science programs and identification as African American, Latina/o, Native American, or Southeast Asian will be used to determine underrepresented status. Prior research demonstrates that generation status is a powerful predictor of academic outcomes, particularly in math and science domains. For example, according to recent figures provided by the National Center for Education Statistics (NCES), approximately 43% of first-generation college students between the years of 1992 and 2000 left postsecondary education prior to completing a degree. Longitudinal data also suggested that compared to their peers, first-generation students were at higher risk for earning lower grades, completing fewer academic credits, withdrawing from courses, and requiring remedial academic assistance (NCES, 2005).

Available research has identified personal and contextual influences on the academic persistence and career development of first-generation students. These influences have been proposed to affect first-generation students both before and during their postsecondary academic experiences. For example, prior to entering college, first-generation students tend to be less academically prepared than their college peers (particularly in math/science domains), have less parental involvement and understanding of college, fear failing out of college, and worry significantly about financial debt. Furthermore, while attending college, first-generation students tend to experience the college environment as unwelcoming, report low support from parental figures, express a need to study more and with greater effort than their peers, and frequently pursue part-time or full-time work to pay for school (Bloom, 2007; Bui, 2002: Hartig & Steigerwald, 2007; McCarron & Inkelas, 2006; Reid & Moore, 2008). Due in part to these personal and contextual barriers, it is perhaps no surprise that low income first-generation students also report doubts about their academic abilities (Bloom, 2007). Collectively, these data suggest that multiple factors contribute to first-generation students' low persistence rates in college and that generation status may predict one's academic performance (e.g., taking advanced math and science classes while in high school) and experiences with environmental supports.

Students of color are also underrepresented in STEM fields, with African American and Latina/o students comprising a large proportion of this population (National Science Board, 2006). Native American and Southeast Asian students also have low academic retention rates in high school and college, which is indicative of their low representation in STEM careers (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010). Furthermore, national data indicate that African American, Latina/o, and Native American students compared to their White peers are less prepared and express less interest in STEM majors, experience lower persistence rates in STEM fields, and achieve fewer baccalaureate degrees in STEM fields (Cassell & Slaughter, 2006). For example, recent data show that less than 12% of graduating baccalaureate engineering majors were from underrepresented racial/ethnic minority groups (National Action Council for Minorities in Engineering, 2008).

In response to these figures, funding for programming has been established to increase the participation of students of color and first-generation students in STEM careers. While published accounts of the effectiveness of STEM programs for underrepresented students are available (e.g., Lam, Srivatsan, Doverspike, Vesalo, & Mawasha, 2005; Russomanno, Best, Ivey, Haddock, Franceschetti, & Hairston, 2010; U.S. Department of Education, 2007b), many offer atheoretical or anecdotal accounts of program activities. Theory-based model testing could improve the development and implementation of STEM programming for underrepresented students.

Social Cognitive Career Theory

Social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994) is an empirically tested framework from which to conceptualize students' math/science goal intentions. Drawing from Bandura's (1986) social cognitive theory, SCCT is domain-specific and postulates triadic reciprocal linkages among individual, contextual, and behavioral dimensions. The individual level of analysis within SCCT includes cognitive-person variables hypothesized to allow individuals to exercise control over their educational and career-related behaviors. Specifically, self-efficacy, outcome expectations, interests, and goals are thought to influence eventual career choice. The contextual level of analysis within SCCT includes individual predispositions, background affordances, learning experiences, and influences proximal to career choice behaviors (see Figure 1).

Person-cognitive variables. According to SCCT, self-efficacy, outcome expectations, interests, and goals represent the pathways through which individuals are able to exercise agency in their career decision-making. Self-efficacy has been defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Within SCCT, self-efficacy functions as a domain-specific, dynamic set of self-beliefs that fully mediate the relation between one's learning experiences and level of interest in a given career. Self-efficacy is also hypothesized to have a direct effect on one's outcome expectations, or "beliefs about the consequences or outcomes of performing particular behaviors" (Lent & Brown, 2006, p. 17). Outcome expectations are in turn postulated to partially mediate the relationship between self-efficacy beliefs and career interests. Finally, career interests are hypothesized to have a direct effect on one's career choice goals. Within SCCT, goals are defined as representing both choice content as well as domain performance. Whereas choice content includes the specified activities of a given career, performance represents, "the level or quality of performance toward which one aspires within a given domain" (Lent & Brown, 2006, p. 17).

Previous studies focusing on cognitive-person variables in math/science domains have demonstrated that self-efficacy and outcome expectations predict career interests and goals (e.g., Betz & Voyten, 1997; Fouad & Smith, 1996; Gore & Leuwerke, 2000;

Lopez, Lent, Brown, & Gore, 1997). Lent et al. (2001) found moderate, positive relationships between math self-efficacy and outcome expectations (r = .41) as well as math self-efficacy and interests (r = .29) in a sample of undergraduate students. Outcome expectations were related to interests and choice goals, as hypothesized in SCCT. In their initial explication of SCCT constructs, Lent et al. (1994) estimated effect sizes of r = .52 and r = .42 for the relations between outcome expectations and interests and goals from prior studies, respectively. Later studies have replicated these findings (Byars-Winston & Fouad, 2008; Lent et al., 2003; Lent et al., 2005; Nauta & Epperson, 2003; Navarro, Flores, & Worthington, 2007).

Contextual variables. Person-inputs, background contextual affordances, learning experiences, and proximal contextual factors represent individual and environmental constructs within SCCT thought to immediately and indirectly influence one's career-related behaviors. Whereas person-inputs are indicative of the traits or predetermined characteristics one enters into the career decision-making process with (e.g., having high levels of intrinsic motivation to know math/science-related information), background contextual affordances are aspects of a person's environment that may help determine their access to resources and role models (e.g., caregivers who are invested in a child's education) associated with a given career (Lent et al., 1994). Perceived supports and barriers are environmental factors hypothesized to play roles during active phases of the career decision-making process. Examples might include perceiving peers to be supportive or having mentors who encourage one to pursue a given career interest (Lent et al., 2000). With regard to directional relations, person-inputs and background contextual affordances are thought to covary and have direct effects on one's learning experiences. Individuals' learning experiences are hypothesized to indirectly relate to career choice goals through other personal-cognitive variables such as self-efficacy, outcome expectations, and interests. That is, enhanced learning experiences (e.g., taking a number of math/science classes in high school) are thought to predict higher levels of self-efficacy, which in turn predicts more positive outcome expectations and increased interest in a specific career domain. Increased interest in a particular career is then hypothesized to predict enhanced goal setting for that career.

Existing research in math and science domains with diverse adolescents and young adults supports these hypothesized relationships (Betz & Voyten, 1997; Fouad & Smith, 1997; Gainor & Lent, 1998; Lent et al., 2005; Navarro et al., 2007). The effects of person-inputs on career interests and goals are hypothesized to be fully mediated by proximal contextual factors. Furthermore, in addition to their direct effects, proximal contextual factors are posited to moderate the relationship between career interests and goals. For example, while a student may express interest in a math-oriented career path, the discouragement from family members to pursue such a career may negate the relationship between the student's interest and goals.

Prior research supports the assertions that person-input variables, such as personality, predict proximal supports (e.g., McWhirter, Hackett, & Bandalos, 1998), and that perceived supports and barriers predict career interests and goals (Lent et al., 2000, 2003). However, contrary to original SCCT hypotheses in which proximal contextual factors directly influence interests and goals, several studies (e.g., Lent et al., 2003; 2005; 2008) have suggested that the effects of proximal supports are fully mediated through self-efficacy—an effect that is more closely aligned with Bandura's (1986) social cognitive theory.

Contextual factors are of primary interest in the current investigation for several reasons. First, developmental declines in math/science interest and performance between middle and high school point to the need to delineate critical variables at these time points. Evidence suggests that intrinsic motivation for math/science domains may be one fruitful target of intervention at the individual level (A. E. Gottfried et al., 2007, 2009). Although it is well-understood that lower intrinsic academic motivation in math and science relates to declines in academic performance within these domains, less is known regarding relationships to math/science career goals. Furthermore, although parents have been cited as critical to the career development of children and adolescents (cf. Whiston & Keller, 2004), there is little information on how parent-child interactions specifically relate to math/science educational performance and career interests in high school students. Similarly, while perceptions of supports and barriers to math/science career pursuits have been shown to relate to math/science self-efficacy and career choice among college students (Lent et al., 2001; 2002), their role in the math/science career decision-making of high school students is less understood. Finally, while programs for underrepresented high school students in math/science domains exist, there is little theoretical base to support points of intervention for these programs. More theory-based exploratory study of critical factors in underrepresented students' career decision-making in math and science could improve these intervention efforts.

Academic intrinsic motivation. Academic intrinsic motivation is included as a person-input variable in the present study. Recent studies suggest that motivation may be a key determinant in the performance and interest of students in math and science from middle to high school. Specifically, math/science performance has been shown to decline from early to late adolescence and to be correlated with intrinsic motivation for math/science (A. E. Gottfried, Fleming, & A. W. Gottfried, 2001; A. E. Gottfried, Marcoulides, A. W. Gottfried, Oliver, & Guerin, 2007; A. E. Gottfried, Marcoulides, A. W. Gottfried, & Oliver, 2009). This is a unique finding, given that general academic motivation has been found to remain relatively stable over time (A. E. Gottfried et al., 2001). Drawing from self-determination theory (SDT; Ryan & Deci, 2000), academic intrinsic motivation assumes that individuals have a natural tendency to strive for self-improvement and that conditions fostering intrinsic motivation will most likely promote self-regulated behavior change (A. E. Gottfried, 1985). Extended to math/science endeavors, students who perceive math/science activities to match their values and self-concept will be more likely to seek out math/science learning experiences.

Research has shown that academic intrinsic motivation is related to academic achievement, perceived academic competence, IQ, parental involvement, prosocial behaviors, internal locus of control, positive emotions in class, and academic persistence intentions (A. E. Gottfried, Fleming, & A. W. Gottfried, 1994; Ryan & Connell, 1989; Vallerand, Blais, Brière, & Pelletìer, 1993). However, the majority of this research has been conducted with predominantly White samples and it is unclear what role academic intrinsic motivation may play in the performance of underrepresented students. Furthermore, while relationships between intrinsic motivation and academic achievement have been established, the link between motivation and career development in STEM domains has not received sufficient attention in prior studies.

Parental support. Parents have been described as inextricably linked to their children's career development through both overt and vicarious influences (Bratcher, 1982; Otto, 2000; Roe, 1956). Indeed, a large body of research accumulated over time has consistently shown that parents exert influence over their children's career aspirations, interests, and choices and that these effects are particularly strong for young children and adolescents (Whiston & Keller, 2004).

Prior studies examining the relationship between parental involvement and career decision-making have supported tenets of SCCT. Specifically, researchers have found direct relationships between parental involvement and career decisions (Tang & Fouad, 1999) as well as indirect relationships between parental involvement and self-efficacy through learning experiences (Ferry, Fouad, & Smith, 2000). Later studies have replicated and extended these findings, showing that parental involvement is indirectly related to math/science career goals through academic self-efficacy, outcome expectations, and interests (Byars-Winston & Fouad, 2008).

However, each of these studies was conducted with college students leaving speculation regarding how results might replicate in high school students. Given that relationships between adolescents and their parents have been shown to be developmentally distinct from later time points, one might expect the association between parental involvement and person-cognitive variables to vary. Specifically, because children typically experience less autonomy from parents in high school as compared to college, it is possible that the relationship between parental involvement and learning experiences could be stronger at this time point.

Perceived environmental supports. While a variety of educational and career supports and barriers have been investigated in prior research (e.g., Kenny & Bledsoe, 2005; McWhirter et al., 1998), this study assesses supports for math/science careers as conceived by Lent et al. (1994) and derived from mixed-method investigation. Specifically, perceived supports and barriers are defined as, “environmental factors that persons perceive as having the potential, respectively, to aid or hinder their efforts to implement a particular educational or occupational goal” (Lent et al., 2001, p. 475).

Lent and colleagues developed a quantitative measure of contextual supports and barriers to assess various environmental influences on students’ career goals (Lent et al., 2002). Furthermore, supports and barriers as measured by this instrument exhibited significant, positive relationships with math/science self-efficacy in a sample of 111 undergraduate students. Tests of moderation indicated that only perceived barriers moderated the relationship between career interests and goals.

In a related study, Lent et al. (2003) examined the role of perceived supports and barriers in the choice to pursue a career in engineering within a sample of 328 undergraduate students. Results indicated that supports and barriers explained 56% of the variance in self-efficacy beliefs and were indirectly related to interests and goals through self-efficacy. These results were replicated in a more recent study with Portuguese high school students (Lent, Paixâo, da Silva, & Leitâo, 2010). Lent and colleagues have interpreted these results as supporting Bandura’s (1999, 2000) hypotheses regarding the relations between proximal environmental influences and choice actions as opposed to those of SCCT. However, one additional study conducted with undergraduates in the computing disciplines suggested that contextual supports and barriers had both direct and indirect effects on goals through self-efficacy (Lent, A. M. Lopez, F. G., Lopez, & Sheu, 2008). Given these findings, additional model testing is necessary in order to compare and determine the relative fit of direct (i.e., direct effects of supports on interests and goals) and indirect (i.e., mediated effects of supports on interests and goals through self-efficacy) SCCT models.

Study Purpose and Hypotheses

There is a need to delineate key variables in the pursuit of math and science careers among diverse groups of students. Although a number of programs exist within the U.S. to promote the skills required of STEM careers, many focus exclusively on teaching and learning with neglect for environmental influences. The relative ineffectiveness of these programs reveals a need for further understanding of factors beyond the classroom that influence students' goals to pursue a STEM career (U.S. Department of Education, 2007a). Consistent with this need, the present study investigates the role of contextual factors in underrepresented high school students' career goals in math and science.

The present study will examine the relations between distal and proximal contextual factors (i.e., academic intrinsic motivation, parental involvement, learning experiences, perceived barriers) and person-cognitive variables (i.e., self-efficacy, outcome expectations, interests, goals) in accord with tenets of SCCT among high school students underrepresented in STEM careers (see Figure 1). Specific hypotheses include:

Hypothesis 1: The hypothesized structural model will provide a good fit to the data and variables will relate as hypothesized by SCCT.

Hypothesis 2: Perceived supports will moderate, and specifically enhance the relationship between interests and goals.

Hypothesis 3: Person-cognitive variables (i.e., self-efficacy, outcome expectations, and interests) will mediate the relations between contextual variables and math/science career goals.

Chapter II

Literature Review

This chapter will provide an overview of the extant literature related to math and science career choice among high school students underrepresented in science, technology, engineering, and math STEM careers. First, the state of science, technology, engineering, and math (STEM) education in the United States (U.S.) will be discussed. Specific details regarding the growth of STEM careers in the U.S., deficiencies in STEM preparation and achievement, as well as the social and economic impact of STEM careers will be outlined. Next, available information regarding the components and outcomes of existing STEM programs will be presented. A review of social cognitive career theory (SCCT) and its utility in predicting STEM career choices will be provided. Specific hypotheses of SCCT related to person-inputs and contextual factors will be highlighted and discussed in terms of their applicability to underrepresented students in STEM.

STEM Education in the United States

Since 1980, STEM careers have grown at a rate four times higher than that of all other occupations. Furthermore, between the years of 2004 and 2014, employers were projected to hire approximately 2.5 million workers in the STEM fields (Terrell, 2006; U.S. Bureau of Labor Statistics, 2007). Most recent available data indicates that between the years of 2004 to 2007, the growth of STEM careers declined somewhat to 3.2%, but remained twice as high as the total U.S. workforce (NSB, 2010a). Current national data on the STEM labor force also highlight concerns regarding the ability to fill positions left vacant by retiring professionals. As of 2006, approximately 26% of individuals in STEM careers were older than age 50, suggesting that a new generation of professionals will soon be needed to occupy jobs vacated in the STEM fields (NSB, 2010a).

Although career opportunities associated with STEM fields are projected to experience sustained growth in the coming years, there remains concern regarding the number of individuals receiving adequate training to occupy STEM occupations. A number of nationwide studies suggest deficiencies in STEM preparation and achievement, particularly for underrepresented groups such as women and students of color (NSB, 2006; NSB, 2010a, U.S. Department of Education, 2007b).

For example, recent data from the Program for International Student Assessment (NCES, 2007) indicate that 15 year olds in the U.S. scored below 7 of 19 other nations for which data were available in 2000 and below 15 nations in 2006 on tests of math and science ability. In a similar national study, the National Assessment of Educational Progress (Perie, Moran, & Lutkus, 2005) determined that just 36% of fourth grade students and 30% of eighth grade students met “proficient” and “advanced” levels of achievement on standardized math tests, respectively. The study also found that the achievement gap between racially and ethnically diverse students had widened in 2005 to levels comparable to those seen in 1990. Other figures place the math and science achievement of U.S. 15 year olds at 28th and 24th in math and science literacy, respectively. Furthermore, the U.S. ranks 20th among all nations in the proportion of college graduates who earn degrees in science and engineering (Kuenzi, 2008). Additional studies provide a more positive assessment of students’ achievement in math and science. Specifically, the recent Trends in Mathematics and Science Study (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008) suggested that U.S. fourth and eighth grade students' scores on measures of math and science ability increased from observed scores in 1995 in math, but not science. Observed math achievement scores placed students within the median of other countries for which data were available.

A number of programs have been established to aid in enhancing students' math/science academic performance throughout the educational pipeline. These intervention programs have also been promoted given the benefits of STEM careers to individuals and society at large. Specifically, STEM careers are characteristically stable, high-paying, and available within the job market. Furthermore, students graduating with degrees in the STEM fields tend to experience a greater variety of choices across occupational disciplines when entering the workforce (National Science Foundation, 2010a). In addition to these individual benefits, STEM fields tend to increase the social and economic well-being of others. Given shifts toward global markets reliant on scientific and technological innovation, many national economies have seen growing reliance on a workforce that is trained and skilled within STEM domains (National Science Foundation, 2010b).

While it is clear that advancing STEM achievement and career preparation is a priority among institutions and policy-makers within the U.S., theory and data-driven models of producing such advancements are lacking (U.S. Department of Education, 2007). In one of the few clearly delineated theories of promoting positive change in STEM education, the National Alliance of State Science and Mathematics Coalitions (NASSMC, 2009) articulated a developmental model of STEM preparation. Specifically, their model proposes a range of formal and informal educational opportunities across the learning spectrum, including: fundamental STEM knowledge and skills in prekindergarten to 5th grade, prerequisite STEM skills in grades 6 through 8, emphasis on STEM career choices in grades 9 through 12, and movement into the STEM disciplines as well as teacher training within higher education. The NASSMC has supported programs meeting their philosophy of change in the form of funding, equipment donations, networking, strategic support, and community outreach.

While current efforts to promote STEM education contain a significant focus on teacher preparation, additional recommendations for enhancing the quality of the STEM workforce include a focus on parents, educational institutions, and community organizations (National Science Board, 2009). The need to increase the participation of students in the STEM career pipeline is reflected in several legislative acts carried out by the U.S. Congress in recent years. Some examples include, but are not limited to the National Aeronautics and Space Administration Act of 2005, National Defense Authorization Act of 2006, Deficit Reduction Act of 2005, and the America COMPETES Act of 2007. Each of these bills established increased funding and educational reforms to aid in promoting student learning and participation in STEM fields (Kuenzi, 2008).

The America COMPETES Act of 2007 also established the Academic Competitiveness Council (ACC), whose mission was to identify federal programs with a math or science focus, evaluate the effectiveness of such programs, determine areas of overlap within federal math and science programs, identify target populations served by existing programs, and provide recommendations to better coordinate federal math and science programs. The ACC conducted a review of federally funded math and science programs in 2007 (U.S. Department of Education, 2007a).

Studies evaluated in the ACC's report included experimental, quasi-experimental, and "other" designs (e.g., pre-post studies and comparison groups studies that did not involve careful matching of participants). The ACC included existing reports from federal agencies related to the effectiveness of programs in their overall evaluation and based conclusions of program effectiveness on student outcomes. Specific outcomes determined relevant by the ACC included student learning (e.g., knowledge and skills related to STEM fields), teacher quality (e.g., increasing number of teachers with advanced degrees in math or science), and engagement (e.g., increase students' interest and participation in STEM careers). These outcomes were consistent with national goals regarding STEM education (U.S. Department of Education, 2007a).

Within their review, the ACC identified 24 elementary and secondary school programs that received an approximate total of $574 million in federal funding, 70 undergraduate, graduate, and postgraduate programs that received approximately $2.4 billion, and 11 informal education and outreach programs that received approximately $137 million. Of these programs, the ACC received 115 evaluations, only 10 of which were classified as "scientifically rigorous." Based on their review of these 115 evaluations, the ACC concluded that, "despite decades of significant federal investment in science and math education, there is a general dearth of evidence of effective practices and activities in STEM education" (U.S. Department of Education, 2007a, p. 3). In addition to revealing a general lack of rigorous evaluation on the part of federally funded programs, the ACC report showed that even among the most rigorously evaluated programs, past federally funded STEM education has had little meaningful positive impact (Kuenzi, 2008).

Despite lack of evidence demonstrating the general effectiveness of STEM education in the U.S., some specific STEM programs have shown promise. One example is the Upward Bound Math-Science (UBMS) program. Established by the U.S. Department of Education in 1990, UBMS was developed in response to low levels of academic achievement among economically disadvantaged K-12 students. To qualify for a UBMS program, a student must belong to a family whose annual income is 150 percent of the poverty line or below and be a potential first-generation college student. The latest executive report regarding UBMS estimated that by race/ethnicity approximately 42% of participants identified as Black, 4% as Latina/o, 37% as multiracial, 1% as American Indian, and 15% as White (U.S. Department of Education, 2007b).

Ingredients of UBMS programs typically include: extracurricular academic instruction in math and science, exposure to careers in math and science through other professionals and mentors, exposure to college, assistance with college applications, academic tutoring, and experiential learning (e.g., personal projects or shadowing). Many UBMS programs are held during the summer on two and four-year college campuses. As of 2004, there were an estimated 127 UBMS programs in the U.S., serving approximately 6,845 students at a cost of $32.8 million (U.S. Department of Education, 2007b).

In an effort to evaluate the effectiveness of UBMS, the U.S. Department of Education compared academic outcomes of students participating in UBMS programs with those of students who applied to enroll in general Upward Bound programs in the 1990's, never participated in UBMS, and had been tracked academically over time. Results from the evaluation indicated that UBMS improved high school grades in math and science as well as overall GPA, increased the likelihood of taking chemistry and physics classes in high school, increased the likelihood of enrolling in more selective four-year institutions, increased the likelihood of majoring in math and science in college, and increased the likelihood of completing a four-year degree in math and science. On the other hand, results also showed the UBMS failed to increase the likelihood of students taking additional math classes in high school (U.S. Department of Education, 2007b).

In addition to revealing a promising intervention, results from the UBMS program indicate that multifaceted efforts may be needed to increase students' math/science interests and performance. That is, although classroom-based learning and instruction are important areas of emphasis, interventions focused on ecological factors such as instrumental support, immersion in math/science activities outside school, and mentorship could prove even more beneficial. While not explicitly discussed in their report, the UBMS program also shows that providing students with learning experiences and contextual supports can have an impact on math/science career-related activities.

Whereas the findings of the ACC make it clear that further research is needed to delineate factors that promote or impede students' pursuit of math and science-related careers, findings of UBMS suggest that it could serve as a model for other programs. Unfortunately, a lack of theory-based programmatic development in STEM education presents challenges with regard to designing, transferring, and replicating effective interventions. In recent years, promising theoretical models have been proposed to help explain the achievement and career decision-making and students in STEM domains. Of these, perhaps the most widely researched and disseminated theory is social cognitive career theory (SCCT; Lent et al., 1994).

Social Cognitive Career Theory

Social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994) has proven to be a useful framework from which to predict the math/science interests and career goals of diverse groups of students (Flores & O'Brien, 2000; Fouad & Smith, 1996; Lent et al., 2000, 2003; Lopez et al., 1997; Mau & Mau, 2006; Nauta & Epperson, 2003; Navarro et al., 2007). Initially conceived by Lent et al. (1994), SCCT follows key propositions and hypotheses explicated in Bandura's (1986) social cognitive theory. Specifically, personal attributes, external environmental factors, and overt behaviors are hypothesized to affect one another in a bidirectional manner. Also known as *triadic reciprocality*, these relations are proposed to take place within a specific domain (e.g., math and science). The initial SCCT theoretical framework (see figure 1) included 12 propositions derived from meta-analyses of previous research and social cognitive theory (Bandura, 1986). Original SCCT assumptions in addition to effect sizes derived from prior research by Lent et al. (1994) are included in Table 1.

Person-cognitive variables. Person-cognitive variables posited in SCCT include self-efficacy, outcome expectations, career interests, career goals, and career choice. Self-efficacy is defined as, "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Within the social cognitive framework, self-efficacy is portrayed as a dynamic set of self-beliefs that are related to, but not synonymous with, one's performance. That is, performance for a given task is thought to be reflective of both skills and beliefs regarding one's ability to carry out that task (Bandura, 1991).

Self-efficacy is in turn thought to predict outcome expectations or "beliefs about the consequences or outcomes of performing particular behaviors" (Lent & Brown, 2006, p. 17). Bandura (1986) classified outcome expectations into physical, social, and self-evaluative categories. Examples of outcome expectations for pursuing a math or science-related career include the perception that a math/science career will lead to financial stability (e.g., physical), one's parents will be pleased with such a career choice (e.g., social), or having a math/science career could lead to a sense of personal fulfillment (e.g., self-evaluative). It has been suggested that self-efficacy beliefs and outcome expectations could differentially predict career interests based on environmental context or task and that self-efficacy may in general be a stronger predictor (Lent et al., 1994).

Career interests are reflective of the overall level of interest one experiences with regard to a specific career domain or academic subject. High levels of interest in a career are then thought to predict goal setting for that career. Therefore, a student who expresses a great deal of interest in occupations clustered within math/science domains would logically be expected to have some personal goals for actively pursuing such a career. Finally, career goals are thought to later predict career choice behaviors, such as choosing an academic major, pursuing internships associated with a particular vocation, and entering a specific career (Lent et al., 1994).

According to social cognitive theory, goals may be set for specific activities or future-oriented outcomes. Furthermore, individuals are thought to set goals in accord with desired outcomes that are reflective of internalized standards. Goals are therefore posited to enhance the probability that one will achieve an outcome and to continue to have impacts in the absence of external reinforcement (Bandura, 1986). Within SCCT, goals are theorized to motivate career-related behaviors such as aspirations, plans, and decisions.

Contextual variables. A somewhat unique focus of SCCT is its explicit attention to environmental influences on one's career development. According to SCCT, one's personal and environmental context can promote or impede success within a given domain through several different means including person inputs, background contextual affordances, and proximal contextual influences on career choice behaviors. These individual and environmental factors may provide vicarious influence as well as have direct, indirect, and moderating effects on one's sociocognitive processes (Lent et al., 1994, 2000).

Person inputs represent individual differences and may include variables such as race, gender, and personality. Although in some ways, person inputs include biological or dispositional features that an individual brings into the career decision-making process they are also subject to social construction. For example, while race may in some ways be considered a dispositional trait in terms of phenotypic characteristics, socially constructed racial categories tend to determine the opportunities, resources, and experiences one has (Sue & Sue, 2003). Therefore, personal characteristics do not directly influence one's career development by their very nature per se; rather they are thought to exert influence from reactions evoked in others on individual and societal levels (Lent et al., 1994). Women, for example, are underrepresented in math-intensive fields due not to inherent abilities as females, but instead because of sociocultural factors (Ceci, Williams, & Barnett, 2009). Within SCCT, person inputs are hypothesized to predict sources of self-efficacy (i.e., learning experiences) and proximal contextual influences (i.e., perceived supports and barriers).

Learning experiences represent another environmental influence that is thought to directly inform self-efficacy beliefs. Within social cognitive theory, self-efficacy is proposed to derive from four separate sources: past performance accomplishments, vicarious learning, social persuasion, and physiological states and reactions (Bandura, 1986). Pertaining to math/science self-efficacy, receiving good grades in past math/science classes, observing a family member or peer performing math/science-related activities, receiving feedback that one should pursue advanced math/science classes, and experiencing positive affect when completing math/science-related tasks would presumably increase one's self-efficacy for math/science tasks. Within SCCT, learning experiences are hypothesized to predict self-efficacy and outcome expectations (Lent et al., 1994, 2000).

Whereas prior learning experiences are hypothesized to inform self-efficacy, background contextual affordances are hypothesized to preempt and help determine access to learning experiences. For example, an individual with the affordance of parents with careers in math/science-related fields may be more likely to receive exposure to the tasks and demands of such careers. This could include becoming familiar with the skills required of similar occupations, observing the social and financial benefits of obtaining such a career, and perceiving a math/science related career as obtainable. Specific background influences proposed in the original SCCT framework included opportunities for exposure to role models, emotional and financial support, and various socialization processes (Lent et al., 1994).

Proximal contextual factors are posited to interact with cognitive and behavioral variables through both objective and subjective influence. For example, while gender discrimination represents an objective barrier to the pursuit of STEM careers for women (e.g., Ceci et al., 2009), phenomenological appraisal of discrimination may also impact the ways in which one responds to such a barrier cognitively and behaviorally. In this sense, "such a view does not minimize the significance of objective features of the environment, but it does highlight the person's active, phenomenological role as the interpreter of contextual inputs" (Lent et al., 1994, p. 106). In distinguishing proximal contextual influences from background contextual factors, Lent and colleagues explicated that proximal factors exert influence at critical junctures in the career decision-making process. That is, whereas background affordances may help determine individual differences with regard to opportunity structures and resources before one begins to pursue a career, proximal influences aid in determining whether one's self-efficacy and outcome expectations for a certain career will lead to associated interests, goals, and actions (Lent et al., 1994, 2000, 2003).

Empirical support for SCCT. A number of studies have been conducted to test assumptions and hypotheses associated with SCCT. In general, these studies have supported general tenets of SCCT, provided evidence of its applicability to diverse cultural groups, and demonstrated empirical evidence for temporal relationships between key variables within the SCCT framework. Meta-analyses have provided additional empirical support for the SCCT model across studies.

Initial tests of SCCT within the math and science domain focused on hypothesized relationships between core person-cognitive variables. In an early study with undergraduate students, Lent, Lopez, and Bieschke (1993) found that the effects of past course achievements on academic interests were mediated by self-efficacy and that interests mediated the relationship between self-efficacy and intentions in math. Furthermore, the effect of past achievements on mathematics grades were partially mediated by self-efficacy while outcome expectations predicted interest and math course enrollment intentions. In later studies, researchers established support for models in which (a) learning experiences predicted self-efficacy, (b) self-efficacy and outcome expectations predicted interest, (c) interests predict goals, and (d) self-efficacy mediated the relationship between learning experiences and performance accomplishments (Fouad & Smith, 1996; Gore & Leuwerke, 2000; Lopez, Lent, Brown, & Gore, 1997). These later studies included middle and high school students from diverse cultural backgrounds.

Later studies have focused more directly on contextual factors presumed to influence agentic pathways to career choice. Lent et al. (2001) designed an instrument based on qualitative interviews with undergraduate students (Lent et al., 2002) to assess perceptions of proximal supports and barriers to career choice. Items for barriers were organized along several dimensions including (a) social and family influences, (b) financial constraints, (c) instructional barriers, and (d) gender and race discrimination. Items for supports were similarly partitioned into (a) social support and encouragement, (b) instrumental assistance, (c) access to role models or mentors, and (d) financial resources domains. Results from a study conducted with undergraduate students indicated that perceived supports and barriers predicted self-efficacy, which in turn predicted outcome expectations and interests. Furthermore, only perceptions of barriers were found to moderate the relationship between interests and goals, partially supporting tenets of

SCCT. Importantly, contrary to initial hypotheses put forth by Lent et al. (1994), proximal contextual variables did not directly relate to interests and choice goals, but were fully mediated through self-efficacy. This finding was interpreted as supporting Bandura's (1986) original hypotheses regarding the relations between contextual supports and self-efficacy as opposed to those of SCCT (Lent et al., 2001). Later studies replicated these findings with undergraduate engineering majors in the United States and high school students in Portugal (Lent et al., 2003; 2010).

Additional research has examined the relations among person-inputs, background contextual factors, learning experiences, and SCCT person-cognitive variables. For example, in a study of Asian American college students, parental involvement predicted career choice (Tang, Fouad, & Smith, 2000). In another study parental encouragement predicted learning experiences, which in turn predicted math/science self-efficacy and outcome expectations in a sample of undergraduate students (Ferry, Fouad, & Smith). In a later study, Byars-Winston and Fouad (2008) examined parental involvement as a background contextual factor predicting the math/science goals of undergraduate students. Results showed that parental involvement predicted math/science self-efficacy and outcome expectations, which in turn predicted interests and goals. In a series of studies with rural Appalachian high school students, socioeconomic status predicted self-efficacy, outcome expectations, and academic aspirations (Ali & McWhirter, 2006; Ali, McWhirter, & Chronister, 2005). Similarly, Navarro et al. (2007) found that social class predicted math/science self-efficacy in a sample of Mexican American middle school students.

Additional studies investigating the role of person-inputs in career decision-making processes outside the math and science domain, have demonstrated that constructs such as gender, gender role stereotypes, ethnic identity, acculturative status, racial identity attitudes, parental education, and locus of control predict self-efficacy, outcome expectations, and performance domains. Furthermore, these studies supported various SCCT hypotheses within diverse samples of Native American, Mexican American, African American, Asian American, and European American students (Byars-Winston, 2006; Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Flores & O'Brien, 2002; Gainor & Lent, 1998; Gushue, 2006; Gushue & Whitson, 2006; Lent et al., 2005; Mau & Mau, 2006; Tang et al., 1999; Turner & Lapan, 2003).

Longitudinal research has provided additional empirical support for SCCT hypotheses and extended knowledge regarding relationships between variables over time. Nauta and Epperson (2003) conducted a 4-year longitudinal design to examine the temporal relations between science, math, and engineering (SME) self-efficacy, outcome expectations, and career choice in a sample of 204 high school girls. Results indicated that high school math/science ability predicted college SME self-efficacy, high school SME self-efficacy predicted college SME self-efficacy, and that choice of a SME major in early college predicted later college SME self-efficacy and SME outcome expectations. In a similar study, researchers examined temporal relations between self-efficacy, outcome expectations, interests, and goals for engineering in a sample of 209 undergraduate students. Results supported a model in which self-efficacy predicted outcome expectations, interests, and goals one semester later. Support was not found for a model in which the latter variables predicted self-efficacy (Lent, Sheu, Singley, Schmidt, Schmidt, & Gloster, 2008).

Recent meta-analytic research also supports hypotheses regarding SCCT person-cognitive variables. Effect sizes estimates for ability, self-efficacy, goals, persistence, and performance relationships have been specifically examined. Using classifications established by Cohen (1992), effect size estimates have been shown to range from small (r = .12 for ability and persistence) to large (r = .70 for ability and self-efficacy) and to confirm predictive assumptions of SCCT. In addition to relationships among variables, accumulated SCCT model fit statistics have been investigated. Based on their review, researchers determined that model fit across studies was good, but improved when academic ability (i.e., scores on academic achievement tests) was used to represent past performance accomplishments as opposed to grade point averages (Brown, Tramayne, Hoxha, Telander, Fan, & Lent, 2008).

In sum, a relatively large body of literature accumulated over time supports assumptions and hypotheses associated with SCCT. One consistent finding, which has implications for future model testing in accord with SCCT, is the relationship between proximal contextual supports and barriers and career interests, goals, and choice behaviors. Specifically, research has demonstrated that the relationship between proximal supports and barriers and interests and goals is fully mediated by self-efficacy (e.g., Lent et al., 2001; 2003). Furthermore, while several studies have previously shown that parental involvement predicts other person-cognitive variables, no studies have examined this relationship among high school students. This is an interesting omission, as parents have been found to exert a great deal of influence over their children's career development in middle and late adolescence (cf. Whiston & Keller, 2004). Additionally, very few studies have examined person-input variables directly related to academic motivation. This is also curious given SCCT's explicit focus on educational and career outcomes and the large role motivation has been shown to play in academic performance, particularly for math and science between childhood and adolescence (Gottfried et al., 2009). The academic experiences of students underrepresented in STEM careers also requires further investigation, as these students will comprise large proportions of the future college-aged population and U.S. workforce (U.S. Census Bureau, 2008) yet have been understudied in the literature.

Academic Intrinsic Motivation

Academic intrinsic motivation is the "enjoyment of school learning characterized by a mastery orientation; curiosity; persistence; task-endogeny; and the learning of challenging, difficult, and novel tasks" (A. E. Gottfried, 1990, p. 525). Consistent with theories of motivation within the educational context, academic intrinsic motivation is theorized to encompass both general and domain-specific learning (A. E. Gottfried, 1985). Assumptions of academic intrinsic motivation also follow from self-determination theory, which asserts that individuals possess an inherent tendency to self-improve and factors that facilitate internal states of motivation will most likely produce intrinsic regulation and behavioral change. Conditions that promote intrinsic motivation are posited to affect an individual's sense of self-control, internal rewards, personal importance, conscious valuing, congruence with self, and inherent satisfaction along the way to sustained behavioral changes (Ryan & Deci, 2000).

Self-determination theory also explicates qualitative differences between several different forms of internal regulation, which comprise intrinsic motivation: introjected regulation, identified regulation, and integrated regulation (Deci & Ryan, 1985). Introjected regulation refers to an individual's ability to adhere to a regulation on the basis of avoidance, coercion, or seduction (Deci, Vallerand, Pelletier, & Ryan, 1991). An example of introjected regulation would be a student who completes their homework in a math class, but only to avoid personal feelings of guilt for not doing so. Identified regulation is characterized by regulated behaviors motivated by external goals. An example would be a student who takes advanced math and science courses because they view this behavior as useful for their future career goals. Integrated regulation is characterized as the most powerful form of intrinsic motivation, and refers to an individual's engagement in a behavior due to its alignment with their personal sense of self, values, needs, and identity (Ryan & Deci, 2000). A student exhibiting integrated regulation would take advanced math and science courses because doing so is experienced as enjoyable and would be an expression of their self-concept.

Applied to education and learning, conditions that foster students' intrinsic motivation, such as reinforcement coupled with the fostering of autonomy, should affect academic self-efficacy, interests, and performance (Deci et al., 1991). For example, a science teacher who praises a student for their performance on any form of self-initiated learning (e.g., completing a science project) while also acknowledging their autonomy in doing so (e.g., praising their hard work and the novelty of their ideas) would be more likely to foster intrinsic motivation for pursuing future study in science compared to a teacher who does not verbally praise, but gives candy to students for completing the project.

Several instruments have been developed to measure academic intrinsic motivation. The Children's Academic Intrinsic Motivation Inventory (CAIMI; Gottfried, 1985) assesses general and domain specific motivation for learning in math, science, social studies, and reading. Research using the CAIMI has evidenced positive relationships between academic intrinsic motivation and school achievement, perceived academic competence, and IQ, and negative relationships with academic anxiety (A. E. Gottfried, 1985, 1990). Path analyses using parent and observational reports have also established positive links between academic intrinsic motivation and parental encouragement of autonomy and negative links with parental reliance on extrinsic rewards (A. E. Gottfried, Fleming, & A. W. Gottfried, 1994). Longitudinal studies using the CAIMI have shown that academic intrinsic motivation for math and science can be differentiated from that for general academic activities. A series of studies conducted by A. E. Gottfried and colleagues demonstrated that whereas general academic intrinsic motivation remains stable throughout the years, math and science motivation experiences gradual decline from childhood to late adolescence (A. E. Gottfried, Fleming, & A. W. Gottfried, 2001; A. E. Gottfried, Marcoulides, A. W. Gottfried, Oliver, & Guerin, 2007; A. E. Gottfried, Marcoulides, A. W. Gottfried, & Oliver, 2009).

Additional scales measuring academic intrinsic motivation have been developed for college students and children. Whereas the CAIMI assesses general intrinsic motivation for learning, the Academic Motivation Scale (AMS; Vallerand, Blais, Brière, & Pelletìer, 1989), Academic Self-Regulation Questionnaire (SRQ-A; Ryan & Connell, 1989), and Learning Self-Regulation Questionnaire (SRQ-L) measure regulatory styles associated with intrinsic and extrinsic motivation (external, introjection, identification, and intrinsic). Studies using these scales have found that various forms of intrinsic regulatory styles are positively related to achievement, prosocial behaviors, internal locus of control, perceived competence, positive emotions in class, academic satisfaction, and school persistence intentions (Ryan & Connell, 1989; Vallerand, Blais, Brière, & Pelletìer, 1993). In contrast to the CAIMI, the AMS scale does not measure domain specific learning and instead offers a general assessment of academic motivation. The SRQ-A and SRQ-L were developed to measure a variety of regulated behaviors, and researchers may adapt them to fit their research needs. However, the SRQ-A was developed and used in elementary school students while the SRQ-L was developed for older students. Given the domain specificity of SCCT and population under investigation, the SRQ-L will be adapted and used in the current study to measure motivation for learning in math and science.

Parental Involvement

Parental involvement refers to specific tasks that parents may engage in to promote their child's career development. Examples include communicating one's aspirations to a child, providing information related to a specific career, or helping a child problem solve perceived barriers to a career goal. Parental involvement has been described as inextricably linked to career development (Bratcher, 1982; Kotrlik & Harrison, 1989; Otto, 2000; Roe, 1956; Schoffer & Kleimer, 1973). Indeed, research has consistently shown that parents exert influence over their children's career aspirations, interests, and choices and that these effects are particularly strong for young children and adolescents (cf. Whiston & Keller, 2004). Because children tend to spend large proportions of time with their parents, it is logical to conclude that parents have a disproportionate number of opportunities to impact their child's career decision-making as compared to teachers, counselors, or school professionals as has been shown in prior research (Kotrlik & Harrison, 1989, Meszaros, Creamer, & Lee, 2009).

Several studies have directly linked parental involvement to career choice. For example, McWhirter, Bledsoe, and Hackett (1998) tested a structural model predicting the educational and career expectations of 282 Mexican American High School girls, 247 Mexican American boys, and 228 European American girls. Results of a path analysis showed that perceived paternal support was directly related to educational plans, whereas maternal support was indirectly related to both educational plans and career commitment through family commitment. Furthermore, multiple group analyses indicated that the path from maternal support to career commitment was significant for Mexican American girls, but not for boys. In a similar study, Tang et al. (1999) found that parental involvement had a direct effect on Asian American undergraduate students' career choice.

Additional studies have found relationships between parental involvement and more proximal indicators of career choice such as career aspirations, outcome expectations, and decision-making self-efficacy. Mau and Bikos (2000) investigated the longitudinal relations between parental expectations and career aspirations in a sample of 14,915 high school students from the National Educational Longitudinal Survey: 1988-94 (NELS: 88-94; National Center for Education Statistics, 1994). The parental involvement variable used in this study consisted of a combination of perceived parental expectations, socioeconomic status, parental school involvement, parental academic involvement, and number of siblings. Results of a logistic multiple regression indicated that parental expectations in grade 10 predicted occupational aspirations (professional versus nonprofessional) in grade twelve.

Kenny and Bledsoe (2005) investigated the relations between parent support and career development in a sample of 322 urban high school students. Results showed that greater parental support was positively related to career outcome expectations and planning and was negatively related to perceptions of educational barriers. Guay, Ratelle, Senecal, Larose, and Deschenes (2006) used a three-year longitudinal design to investigate temporal relations between perceived parental support and career indecision in a sample of 325 college students in Quebec, Canada. Results indicated that a combination of parental autonomy support, involvement, and informational feedback was related to lower levels of career indecision at each data point. Keller and Whiston (2008) examined relations between parenting behaviors and career development in a sample of 293 middle school students. Regression analyses suggested that both general (e.g., talking with their child about teenage issues) and career-specific (e.g., expressing high career expectations of their child) parenting behaviors predicted greater levels of career decision self-efficacy and career maturity.

Other studies of parental involvement and academic or career-related outcomes have focused on potential mediating variables such as self-efficacy. For example, Ferry et al. (2000) found an indirect effect from parental encouragement to math/science self-efficacy and outcome expectations through math/science grades. That is, higher perceived levels of encouragement from parents related to math and science predicted higher math/science grades, which in turn predicted math/science self-efficacy and outcome expectations. Byars-Winston and Fouad (2008) similarly found that parental expectations and encouragement for math and science career choice (i.e., parental involvement) predicted math and science career goals. Furthermore, this relationship was partially mediated through students' reported levels of academic self-efficacy, outcome expectations, and career interests in math and science domains.

In order to achieve a more nuanced picture of the role of family influence on career development, Schultheiss, Kress, Manzi, and Glasscock (2001) conducted a qualitative examination of relational influences and the career development of 14 college students. Results indicated that several different forms of parental support played a role in students' experiences. The authors coded these themes as Emotional Support, Social Integration, Esteem Support, Tangible Assistance, and Informational Support. Whereas emotional support and social integration referred to efforts made by parents to listen to and validate their child's concerns or struggles, esteem support referred to messages of encouragement to pursue certain career paths. Finally, tangible assistance and informational support referred to direct advice or behavioral support (e.g., providing information on a specific career) given to participants by their parents and others.

Results of studies on parental support and career development provide evidence that parents play a critical role in their child's career aspirations, self-beliefs, and choices. Available literature also indicates that several different forms of support may account for these effects. It appears that parent's emotional support (e.g., empathic understanding and communication), self-efficacy support (encouragement, aspirations), and behavioral support (advice, information-giving) all influence the career trajectories of children.

One issue with current literature related to parental involvement and career outcomes, is inconsistency in construct definition and measurement. For instance, although Tang et al. (1999) found a positive relationship between parental involvement and career choice, it should be noted the parental involvement scale used in this study demonstrated a low scale score reliability estimate (α = .59), suggesting the items used may not have represented a unitary construct. Later studies have successfully used validated measures of parental involvement and further differentiated this construct from those that are more proximal to career decision-making, such as barriers to career persistence (e.g., Ferry et al., 2000; Byars-Winston & Fouad, 2008).

Underrepresented Students and STEM

Approximately 4.5 million, or 24%, of students in the United States higher education system have parents who did not attend college (Engle & Tinto, 2008). Current projections also indicate that African American, Latina/o, Asian, and Native American (ALANA) students will constitute large proportions of the future college-aged population (U.S. Census Bureau, 2008). These numbers reflect naturally occurring demographic changes as well as the fact that completing a bachelor's degree has become increasingly associated with social and economic well-being for individuals and social groups. Furthermore, for the U.S. to maintain a competitive role in an increasingly global economy, it will be necessary to not only provide access, but to also promote academic and career success among underrepresented student populations (Engle & Tinto, 2008; NSB, 2006). Math and science careers have been cited as viable pathways to social mobility as well as important to the economic stability of the U.S. (Betz, 1983; Betz & Hackett, 1985; Lent, Brown, & Hackett, 1994, NSB, 2006).

According to recent figures provided by the National Center for Education Statistics (NCES), approximately 43% of first-generation college students between the years of 1992 and 2000 left postsecondary education prior to completing a degree. Longitudinal data also suggested that compared to their peers, first-generation students were at higher risk for earning lower grades, completing fewer academic credits, withdrawing from courses, and requiring remedial academic assistance (NCES, 2005). Similarly, students of color have been shown to experience lower levels of academic achievement, persistence, and educational attainment (Choy, 2002; Gloria, Castellanos, Lopez, & Rosales, 2005; National Action Council for Minorities in Engineering [NACME], 2008; Pew Hispanic Center, 2005; U.S. Census Bureau, 2006).

Available research has identified personal and contextual influences on the academic persistence and career development of students underrepresented in STEM careers. These influences have been proposed to affect underrepresented students both before and during their postsecondary academic experiences. For example, prior to entering college, underrepresented students tend to be less academically prepared than their college peers (particularly in math/science domains), have less parental involvement and understanding of college, and report low confidence regarding their academic performance. Furthermore, while attending college, underrepresented students tend to experience the college environment as unwelcoming, report low social support, express a need to study more and with greater effort than their peers, and frequently pursue part-time or full-time work to pay for school (Bloom, 2007; Bui, 2002: Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Hartig & Steigerwald, 2007; McCarron & Inkelas, 2006; Reid & Moore, 2008). Collectively, these data suggest that multiple factors contribute to underrepresented students' low persistence rates in education generally, and attenuation in math and science domains, specifically.

Existing studies suggest that low levels of self-efficacy, low levels of social support, poor academic preparation, lower social capital, and concerns related to "social class jumping" play a collective role in the underrepresentation of first-generation and ALANA students in math and science oriented careers (Bloom, 2007; Byars-Winston et al., 2010; Hsaio, 1992; Lent, Sheu, Gloster, & Wilkins, 2010; Nelson, Englar-Carlson, Tierney, & Hau, 2006; Striplin, 1999; Thayer, 2000). Nonetheless, promoting success in math and science domains may play a critical role in the future well-being of underrepresented students, as math and science careers tend to be high paying and can lead to social mobility (Betz, 1994). To date, no studies have examined the relations between personal, contextual, and behavioral variables as they relate to math/science career goals in underrepresented high school students. Such studies are needed, as first-generation and ALANA individuals represent a significant, and increasing number of students attending institutions of higher education (Engle & Tinto; NCES, 2005).

Lent and colleagues' (1994) SCCT model provides a useful framework from which to conceptualize the career choice processes of underrepresented students. Specifically, SCCT posits that personal (e.g., self-efficacy, learning experiences, outcome expectations), contextual (e.g., mentors), and behavioral (e.g., career actions) factors interact to influence the academic and career decisions of individuals. The use of SCCT with underrepresented students seems particularly appropriate given that the constructs represented in the SCCT model reflect variables shown to play a role in first-generation and ALANA students' academic and career development (Choy, 2001, Gainor & Lent, 2005).

As stated previously, SCCT asserts that individual's learning experiences are indirectly related to career choice goals through other personal-cognitive variables such as self-efficacy, outcome expectations, and interests. That is, enhanced learning experiences (e.g., taking a number of math/science classes in high school) are thought to predict higher levels of self-efficacy, which in turn predicts more positive outcome expectations and increased interest in a specific career domain. Increased interest in a particular career is then hypothesized to predict enhanced goal setting for that career. Underrepresented students have been found to experience less frequent and meaningful learning experiences as compared to their peers, particularly within math and science domains (Engle & Tinto, 2008; NCES, 2002, 2005).

Contextual supports also play a critical role in the SCCT framework. Specifically, proximal supports such as parents, peers, and mentors are hypothesized to predict one's self-efficacy and choice goals. Additionally, contextual supports may also moderate the relations between interests and choice goals. For underrepresented students, access to social support has been identified as critical to academic persistence and success (Gloria et al., 2005; Choy, 2001; Engle & Tinto, 2008).

The SCCT model also proposes that background contextual affordances play a role in one's learning experiences. With regard to underrepresented students, parental involvement is one contextual affordance that may predict the extent and quality of meaningful academic learning experiences. More specifically, lower levels of parental involvement have been linked to fewer learning opportunities (e.g., advanced placement math and science courses in high school) and decreased access to knowledge regarding navigating the college experience (Bloom, 2007; Engle & Tinto, 2008).

Summary

The literature summarized above indicates that (a) there is a need to further study math/science achievement and career choice among high school students underrepresented in STEM careers (b) SCCT is a viable theory from which to examine math/science career decision-making and from which to inform intervention efforts, and (c) contextual factors such as academic intrinsic motivation, parental involvement, and perceptions of proximal contextual supports can serve as unique and important foci of future research and intervention efforts. Therefore, this study aimed to examine the math/science career goals of underrepresented high school students. Specific focus was given to contextual factors including academic intrinsic motivation, parental involvement, and perceptions of proximal supports.

Chapter III

Method

The present study examined the relations between distal and proximal contextual factors (i.e., academic intrinsic motivation, parental involvement, learning experiences, perceived barriers) and person-cognitive variables (i.e., self-efficacy, outcome expectations, interests, goals) in accord with tenets of SCCT among high school students underrepresented in STEM careers. This chapter addresses characteristics of the sample included in this study, instruments used to measure constructs, and the research design implemented to test research hypotheses.

Participants and Procedure

Participants were 341 high school students participating in federal TRIO programs (i.e., Upward Bound, Talent Search) for students underrepresented in higher education. To qualify for a TRIO program, a student must belong to a family whose annual income is 150 percent of the poverty line or below or be a prospective first-generation college student (i.e., neither parent has received a Bachelor’s degree). The latest executive report regarding TRIO programs estimated that by race/ethnicity approximately 42% of participants identified as Black, 4% as Latina/o, 37% as multiracial, 1% as American Indian, and 15% as White (U.S. Department of Education, 2007b). A total of eight TRIO programs serving students in urban and rural areas of the Midwestern United States served as sites for data collection.

The majority of participants in the present study were female (n = 193, 63.3%). By race/ethnicity, 15.7% (n = 48) of participants identified as “Mexican American,” 20% (n = 61) identified as African American, 35% (n = 109) identified as White (non-

Hispanic), 17.4% (*n* = 53) identified as Asian American, and 5.2% (*n* = 16) identified as "biracial/multiracial." The remaining participants identified as "South American" (*n* = 2, 0.7%), "Spanish American" (*n* = 3, 1%), "Central American" (*n* = 6, 2%),"Native American" (n = 1, 0.3%), and "other" (*n* = 4, 1.3%). Within Asian American participants, the majority identified as "Hmong" (*n* = 30, 9.8% of the total sample). Remaining subgroups represented included "Korean" (*n* = 1), "Laos" (*n* = 1), "Taiwanese" (*n* = 1), "Thai" (n = 1), and "Vietnamese" (*n* = 10). By class rank, 30% (*n* = 94) were freshmen, 28.5% (*n* = 87) were sophomores, 22.3% (*n* = 68) were juniors, and 17.5% (*n* = 53) were seniors. Approximately 56% (*n* = 172) of students qualified for free and reduced lunch and 62% (*n* = 190) of students qualified for reduced lunch only. The majority of participants (35%, *n* = 96) reported their female head of household's education as "high school graduate" followed by "less than 7th grade" (15%, *n* = 43). Similarly, the majority of male head of household's education levels were reported as "high school graduate" (36%, *n* = 93) followed by "less than 7th grade" (17.1%, *n* = 44). A majority of students (58.7%, *n* = 175) endorsed "graduate degree" as their highest educational goal, followed by "standard college graduate" (36.2%, *n* = 108).

IRB approval was granted and permission to recruit participants was obtained from individual TRIO program directors prior to data collection. Participants were recruited through announcements at scheduled program activities provided by TRIO program directors. Announcements included information regarding the aim and scope of the study as well as eligibility criteria for participation, potential risks, benefits, and information concerning privacy and confidentiality. Assent forms were also administered and collected at this time. Informational letters were provided to parents that detailed the purpose and nature of the study.

Students who met eligibility criteria for the study and signed assent forms were administered surveys by TRIO program directors. Program directors later mailed surveys back to the principle investigator for data entry. Surveys took approximately 30 minutes to complete and students were able to enter a raffle for five $25 Wal-Mart gift cards as incentive for participation. A total of 683 surveys were distributed to ten TRIO programs in six states (MO, KS, OH, WI, IA, MN) and 369 surveys were returned. Of those surveys returned, 341 were usable, resulting in a 49.99% return rate. This percentage was above the recommended return rate of 40% to ensure accurate and reliable data (Kramer, Schmalenberg, Brewer,Verran, & Keller-Unger, 2009)

Measures

Demographic questionnaire. Participants completed a brief demographic questionnaire that included questions regarding age, gender, race/ethnicity, class rank, parental education level(s) and occupations, perceived social class, previous coursework, and educational goals.

Academic motivation. Students' motivation for learning in math and science domains was assessed with the Reasons for Learning Questionnaire (SRQ-L; Williams & Deci, 1996). The SRQ-L is a 12-item self-report instrument developed to measure internal and external regulatory styles associated with motivation for learning in specific academic domains. Items are rated on a Likert-type scale ranging from 1 (*not true at all*) to 7 (*very true*). Five items on the SRQ-L are representative of autonomous regulation (i.e., intrinsic motivation) and seven items are indicative of controlled regulation (i.e., extrinsic motivation). Participants rate items associated with four different prompts relevant to participation in classes, following an instructor's suggestions, and expanding one's knowledge. Sample items include, "Because I would feel proud of myself if I did well in the course," "Because I would get a bad grade if I didn't do what he/she suggests," and "Because it's interesting to learn about the nature of ____________." "Items are written in a general manner such that investigators can adapt the instrument to measure various domains of learning. For the present study, items were adapted to measure motivation for learning in math and science.

Scores on the SRQ-L can be calculated in two ways—for subscale scores or full scale scores indicative of controlled regulation. To produce a full scale score, a Relative Autonomy Index (RAI) may be created by subtracting the averaged controlled subscale score from the averaged autonomous subscale. Higher scores on the RAI are indicative of more autonomous regulation for learning.

Coefficient alphas for subscale scores on the SRQ-L have ranged between .75 and .80 and validity for the measure has been demonstrated through correlations between SRQ-L subscales and measures of general perceived locus of causality as well as perceived competence (Williams & Deci, 1996). Specifically, positive correlations of r = .33 and r = .22 were obtained for scores on the autonomous regulation subscale of the SRQ-L and autonomous control and perceived competence. Correlations of r = .27 and r = .45 were found between scores on the controlled regulation subscale and controlled and impersonal control, respectively. Furthermore, scores on the RAI index of the SRQ-L have exhibited a positive correlation with scores on a measure of autonomous control (r = .18) and a negative correlation with scores on a measure of impersonal control (r = -.35) in a sample of medical students (Williams & Deci, 1996). A study using the SRQ-L with college students found positive correlations between autonomous control and enjoyment of learning, interest, performance, and goal setting and a negative correlation with academic anxiety (Black & Deci, 2000). Coefficient alpha for subscale scores on the SRQ-L in the present study was .79 for the autonomous control subscale and .67 for the controlled regulation subscale. The RAI index was calculated and used in all data analyses.

Learning experiences. Participants' prior learning experiences were assessed with the Learning Experiences Questionnaire (LEQ; Schaub & Tokar, 2005). The LEQ is a 120-item self-report measure designed to assess learning experiences for each of Holland's (1997) RIASEC occupational themes. For the purposes of the present study, only the 20 items developed for Investigative theme learning experiences were used. Items on the LEQ were developed to tap into Bandura's (1986) four proposed sources of self-efficacy (i.e., performance accomplishments, vicarious learning, verbal persuasion, and physiological/emotional arousal) and are rated on a Likert-type scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Total scale scores are obtained by averaging items for each source of self-efficacy. Sample items include, "I performed well in biology classes in school" (performance accomplishments), "I have become nervous while solving math problems" (physiological/emotional arousal), "In school, I saw teachers whom I admired work on science projects" (vicarious learning), and, "People whom I respect have encouraged me to work hard in math courses" (verbal persuasion).
A Cronbach's alpha of .84 for scale scores on the LEQ has been reported in prior research (Schaub & Tokar, 2005) and construct validity for the scale has been established

through observed relations to self-efficacy and outcome expectations for all Holland (1997) occupational themes (Schaub & Tokar, 2005). Coefficient alpha for scale scores on the LEQ in the present study was .89.

Math/science intentions and goals. Participants' intentions and goals in math and science were assessed with the Math/Science Intentions and Goals Scale (MSIGS; Fouad & Smith, 1996). Initially developed for middle school students and later modified for college students, the MSIGS includes 7 items that assess students' intentions to pursue and persist in math and science-related school activities and future career plans. Sample items include, "I plan to take more math classes in college than will be required of me," and "I intend to enter a career that will use science." Items are rated on a Likert-type scale ranging from 1 (*very strongly disagree*) to 5 (*very strongly agree*) with greater scores reflective of higher levels of math/science intentions and goals. Scores are computed by summing and averaging items.

An alpha coefficient of .81 has been reported for scale scores on the MSIGS in prior studies (Fouad & Smith, 1996; Navarro et al., 2007). Furthermore, convergent validity has been established through observed correlations with math/science interests (r = .45), self-efficacy (r = .44), and outcome expectations (r = .54; Fouad & Smith, 1996). Coefficient alpha for scale scores on the MSIGS in the present study was .90.

Math/science interests. Interests in math and science-related domains were measured with the Math/Science Interest Scale (MSIS; Smith & Fouad, 1999). The measure includes 17 items rated on a Likert-type scale ranging from 1 (*very strongly dislike*) to 6 (*very strongly like*). Sample items include, "taking classes in science," and "solving math problems." Item responses are averaged with higher scores indicative of greater math and science-related interests.

The scale has demonstrated adequate scale score reliability estimates, with Cronbach's alphas ranging from .90 to .91 in college and middle school samples, respectively (Smith & Fouad, 1999; Navarro et al., 2007). Validity for the interests measure has been established through observed relationships with math/science self-efficacy, outcome expectations, and goal intentions (Smith & Fouad, 1999; Navarro et al., 2007). Coefficient alpha for scale scores on the MSIS in the present study was .94.

Math/science self-efficacy. The Expanded Skills Confidence Inventory for High School Students (ESCI-HS; Betz & Wolfe, 2005) was used to measure participants' self-reported levels of math/science self-efficacy. The ESCI-HS is a 112-item revised version of the original ESCI (Betz, Borgen, Rottinghaus, Paulsen, Halper, & Harmon, 2003) adapted for high school students. The instrument is designed to measure 14 domains based on Holland themes (Holland, 1997). For the purpose of the present study, only two subscales were used: the 8-item Math subscale and the 8-item Science subscale. These subscales assess self-reported confidence in one's ability to perform an activity, task, or school subject associated with math or science. Items are rated on a 5-point Likert-type scale ranging from 1 (*no confidence*) to 5 (*complete confidence*) with higher scores indicative of greater self-efficacy. Sample items include, "Calculate a shooting percentage in basketball" for the Math subscale and, "Study the way the human mind works" for the Science subscale. Scores are computed by averaging items.

The Math and Science subscales of the ESCI-HS have exhibited adequate scale score reliability estimates ranging from .80 to .88 for the Math subscale and .79 to .90 for the Science subscale. Validity for ESCI-HS scores has been demonstrated through observations of item-total correlations as well as correlations with Holland theme scores of the Skills Confidence Inventory (SCI; Betz, Harmon, Borgen, 1996; Betz & Wolfe, 2005). To reduce the number of estimated model parameters and conserve statistical power in the present study, the Math and Science subscales were combined to produce a single indicator of math/science self-efficacy. Coefficient alpha for scale scores on this measure was .92.

Outcome expectations. Outcome expectations were measured with a 10-item math/science outcome expectations scale (Lent et al., 1993). The scale assesses students' perceptions of the positive outcomes that could result from obtaining a degree in a math or science-related career. Items are rated on a Likert-type scale ranging from 0 (*strongly disagree*) to 9 (*strongly agree*). Sample items include, "receive a good job offer," and "earn an attractive salary." Items are averaged with higher scores indicative of higher outcome expectations for math/science careers.

Prior studies using the scale in college student samples have yielded adequate scale score reliability estimates with Cronbach's alphas ranging from .90 to .91 (Lent et al., 1991, 2003). Furthermore, validity for the scale has been established through observed correlations with math and science-related self-efficacy (r = .54), interests (r = .61), and intentions (r = .46). Coefficient alpha for scale scores on this measure in the present study was .93.

Parental support. Parental support was measured with a modified version of the Fennema-Sherman Math Attitudes Scale (FSMAS; Fennema & Sherman, 1976). The modified FSMAS is an 8-item measure that assesses perceptions of parental encouragement and expectations for pursuing math/science-related activities. A sample item is, “my mother thinks I could do good in math.” Items are rated on a Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). For the present study, the 16-item responses for perceived support for math and science were added to create a scale score.

Internal consistency estimates ranging from .70 to .86 have been found for the modified FSMAS in prior research with middle school students (Turner, Steward, & Lapan, 2004). Convergent validity for the modified FSMAS has been established through observed correlations with measures of math self-efficacy (r = .16), outcome expectations (r = .38), and academic performance (r = ..25) (Alliman-Brissett & Turner, 2010). Coefficient alpha for scale scores on the modified FSMAS in the present study was .87.

Proximal supports. Participants’ perceptions of proximal supports were assessed using a measure developed by Lent et al. (2001) and modified by Lent, Brown, Nota, and Soresi (2003). The instrument includes four Likert-type items rated on a scale ranging from 1 (*not at all likely*) to 7 (*extremely likely*) and assesses perceived supports for students’ decision to pursue math/science careers. Items were generated in accord with several categories reported by participants in prior research, including: a) social support and encouragement, b) instrumental assistance, c) access to role models or mentors, d) and financial resources (Lent et al., 2001). A sample item is, “feel support for this decision from important people in my life.” Items are averaged with higher scores indicative of greater perceived supports for math/science pursuits.

Prior research in undergraduate samples has demonstrated adequate scale score reliability estimates (Cronbach’s α= .88; Lent et al., 2003). Validity for the scale has been established through observed correlations with math/science self-efficacy (r = .34), outcome expectations r = (.32), interests (r = .26), and goals (r = .23) among college students (Lent et al., 2001; 2003). The scale has also been successfully used with Italian and Portuguese high school students, with Cronbach's alphas ranging from .81 to .88 and observed correlations with self-efficacy, interests, and goals for Investigative-themed careers (Lent, Brown, Nota, Soresi, 2003; Lent, Paixão, da Silva, & Leitão, 2010). Coefficient alpha for scale scores in the present study was .90.

Research Design

A descriptive quantitative research design was implemented in the present study. Structural equation modeling (SEM) was used to examine overall fit of the hypothesized model as well as relations among variables. Bootstrapping was used to test for mediation effects (Mallinckrodt, Wei, Russell, & Zakhalik, 2006). Established statistical procedures for testing moderation effects tests in SEM were also used (Kline, 2005; Little, Card, Bovaird, Preacher, & Crandall, 2007).

Several fit indices were used to evaluate the fit of hypothesized and alternative structural models (Martens, 2005). Model A was an indirect effects model and included indirect effects of perceived supports on interests and goals through self-efficacy. Model B was a direct effects model with direct paths from perceived supports to interests and goals. It was hypothesized that Model A would provide a better fit to the data given the results of prior research (Lent et al., 2001; Lent et al., 2003; Lent et al., 2010). Mediator and moderator hypotheses were also tested in the present study.

Sample size. The approximate sample size for the current study was estimated using recommendations for SEM proposed by several authors (e.g., Kline, 2005;

MacCallum & Austin, 2000; Weston & Gore, 2006). Kline (2005) designated samples less than 100 as "small," between 100-200 as "medium," and over 200 as "large" while Weston and Gore (2006) suggested that at least 200 participants be used for any SEM analysis. Noting that as model complexity increases, the accuracy of parameter estimates decreases in smaller samples, MacCallum and Austin (2000) suggested that researchers avoid use of small samples (i.e., $N < 100$) in SEM analyses. Additional guidelines for SEM sample sizes include obtaining 10-20 participants for each freely estimated parameter within a model and the need for increasingly large sample sizes as the degrees of freedom (df_M) within a model decrease (Kline, 2005).

The hypothesized model in the current study included 40 observations (where number of observations = $v [v + 1]/2$) and 20 estimated parameters. Using a liberal estimate of at least 10 cases per parameter, a minimum sample size of 200 was needed in the present study while the df_M in the present study was 20 (i.e., observations – parameters or 40 – 20). Given these sample size considerations, a sample of 341 was deemed sufficient for the present investigation.

Chapter IV

Results

Missing Data and Data Cleaning

Missing data was addressed through the recommended procedures outlined by Schlomer, Bauman, and Card (2010). First, the pattern of missingness was examined to determine if data were missing completely at random (MCAR), missing at random (MAR), or not missing completely at random (NMCR). Results of these analyses are included in the preliminary analyses section.

Plan of analysis. All constructs in the present study were measured using observed variables and statistical analyses were conducted using the AMOS 19 (Arbuckle, 2010) statistical package and the maximum likelihood (ML) estimation method. Specific indices to be examined included the a) Tucker-Lewis index (TLI), b) incremental fit index (IFI) c) comparative fit index (CFI), and d) root mean square error approximation (RMSEA). Researchers have found that these model fit indices are less susceptible to bias by extraneous factors such as model misspecification and sample size (Hu & Bentler, 1998; Martens, 2005). CFI, IFI, and TLI values $\geq .95$ and RMSEA $\leq .05$ generally represent very close model-to-data fit (Kline, 2005; Loehlin, 1998; Steiger, 1998).

Main study hypotheses were examined using path analysis. Hypothesized and alternative structural models including academic intrinsic motivation, parental involvement, learning experiences, math/science self-efficacy, outcome expectations, interests, proximal supports, and choice goals were examined. The hypothesized model included indirect effects from supports to interests and goals through self-efficacy, whereas the alternative model included direct effects from support to interests and goals. Furthermore, the moderating effect of supports on the relationship between interests and goals was examined in the alternative model. Model fit was assessed using recommended indices for SEM. Alternative models were assessed using the chi-square difference test in the case of nested models, descriptive comparisons of fit indices, and the Aikake information criterion (AIC). Statistically significant chi-square difference tests and AIC value differences of 10 or more have been recommended as indicators of significant differences in model fit, with lower AIC values representative of better fit to the data (Kline, 2005; MacCallum & Austin, 2000).

Three mediation hypotheses were also tested, including the proposed indirect effects of: a) academic intrinsic motivation and parental involvement on interests and goals through learning experiences, self-efficacy, and outcome expectations, and b) supports on interests and choice goals through self-efficacy and c) self-efficacy on goals through interests. Mediation tests were conducted using the bootstrapping method. Specifically, 10,000 random samples were generated with 95% bias-corrected confidence intervals examined for statistical significance. Confidence intervals not including zero were indicative of a mediation effect (Kline, 2005; Mallinckrodt et al., 2006).

Furthermore, because SCCT asserts that proximal contextual influences may moderate the relations between interests and goals, tests were conducted to examine the moderating effect of supports on the relationship between interests and goals. An interaction effect between interests and supports was calculated using recommended procedures (Frazier, Tix, & Barron, 2005). This interaction effect was included as an observed variable in the direct effects model and significant paths between a) interests and the interaction term and b) the interaction term and goals were deemed to be indicative of a moderation effect (Kline, 2005).

Preliminary Analyses

The means, standard deviations, and intercorrelations among study variables are presented in Table 2. Data were first examined to assess the pattern of missingness. Specifically, the Missing Values Analysis function in IBM SPSS 19.0 was used to determine if data were MCAR. Little's MCAR test was not significant ($\chi^2 = 94.58$, $p > .05$). suggesting the data were MCAR (Schlomer et al., 2010). Examination of missing data patterns on individual variables revealed percentages of missing data ranging from 1.2% on proximal supports to 3.2% on math/science intentions and goals, parental support, and the controlled regulation subscale of the RSLQ.

Next, a liberal estimate of 20% missing data on study variables was used to determine case deletion. This estimate has been suggested for studies in which deletion of a large number of participants could adversely affect statistical power (Schlomer et al., 2010). Using this criterion, a total of 30 cases were deleted due to excessive missing data. The full information maximum likelihood method (FIML) procedure was used to address missing data values in all analyses. The FIML is a model-based method that estimates parameters and implied values for missing data based on available complete data. The FIML method has been shown to produce unbiased parameter estimates and standard errors and has evidenced superior performance to other common missing value imputations such as mean substitution (Scholmer et al., 2010).

Data were next examined to ensure they met multivariate assumptions. Three cases exhibited z-scores above the critical value of 3.29 and were deleted as univariate outliers. Three additional cases had Mahalanobis distance values above the critical chi-square value of 29.59 and were deleted as multivariate outliers. Examination of skewness and kurtosis statistics suggested that outcome expectations was negatively skewed (skewness = -1.036). Therefore a reflection and square root transformation was conducted on outcome expectation scores. Follow-up tests indicated that data met assumptions of normality, linearity, and homeoscedasticity. Bivariate correlations revealed that all main study variables were correlated at the $p < .01$ level or below and that ethnicity was significantly correlated ($r = .12$, $p < .05$) with scores on the RAI. Therefore, a one-way analysis of variance (ANOVA) was conducted to examine mean differences between groups. Results of the one-way ANOVA were not significant, $F(3, 277) = 2.39$, $p = .06$, suggesting no statistically significant differences on intrinsic academic motivation between ethnic groups. Because no additional demographic variables were significantly correlated with main study variables, analyses were conducted on the sample as a whole.

Primary Analyses

A path analysis was conducted to examine fit of the hypothesized SCCT model to the data. Results of the path analysis suggested that Model A was not a good fit to the data (see Figure 1). Specifically, IFI, TLI, and CFI values all fell within the .54 to .75 range (see Table 3); well below the recommended .90 to .95 range indicative of adequate to good model fit (Kline, 2005). Furthermore, the RMSEA statistic fell within the .18 to .23 range (90% confidence interval) also indicating poor model fit.

Examination of parameter estimates revealed that all paths were statistically significant. Bootstrapping estimates were examined to test the indirect effects of academic intrinsic motivation, parental support, and proximal supports on interests and goals. Results (see Table 4) indicated that the indirect effects from academic intrinsic motivation, parental support, and proximal supports to math/science interests and goals were all significant ($p < .01$). The model explained 16% of the variance in interests and 20% of the variance in goals.

The direct effects model was then tested (Model B), with direct paths from proximal supports to goals as well as a modeled interaction effect between proximal supports and interests (see Figure 3). The interaction term was created by centering interests and proximal supports variables and then calculating their product to form a new variable (Frazier et al., 2004). The resulting model fit statistics again suggested the model was a poor fit to the data, with IFI, TLI, and CFI values falling within the .56 to .74 range and the RMSEA statistic falling within the .16 to .20 range (90% confidence interval; see Table 3). Furthermore, the path from the interaction term to goals was not significant ($p > .05$), suggesting proximal supports did not moderate the relationship between interests and goals. All other paths in the model were statistically significant. This model explained 16% of the variance in interests and 18% of the variance in goals.

Examination of residuals suggested that several parameters could be added to the structural model to improve model fit. Furthermore, adding these paths did not change directional patterns of relationships between variables. Specifically, paths were added between academic motivation and math/science self-efficacy, parent support and outcome expectations, as well as learning experiences and outcome expectations. Additionally, indirect and direct effects were included from proximal supports to math/science self-efficacy, interests, and goals. Results of this model again indicated poor model fit with

IFI, TLI, and CFI values falling within the .63 to .86 range and the RMSEA statistic falling within the .16 to .22 range (90% confidence interval; see Table 3). However, the AIC value of 189.90 was well below those of alternative models, suggesting this model provided the best fit to the data relative to other models tested in this study. This model explained 22% of the variance in interests and 19% of the variance in goals

Chapter V

Discussion

This study used SCCT as a guiding framework to examine the math/science goal intentions of low-income, prospective first generation college students. Support for hypotheses of the present study were mixed. The first hypothesis, that Model A would provide a good fit to the data and all variables would relate as proposed, was only partially supported. Specifically, all variables in the model showed statistically significant paths and were positive predictors of criterion variables. However, fit statistics for all models tested indicated that the hypothesized models were poor fits to the data. Therefore, specific directional relations between variables in this study, as proposed by SCCT, were not supported. There are several methodological issues that may help explain these findings.

First, this study tested an extended SCCT model whereas many other studies using SCCT as a guiding framework have not. Specifically, with the exception of actions and performance, this study used variables to represent every other construct hypothesized by SCCT (Lent et al., 1994; Lent et al., 2000). Other studies in which hypothesized SCCT models have provided better fit to the data have only tested portions of the full theoretical model. For example, Fouad and Smith (1996) omitted background contextual affordances, learning experiences, and proximal contextual supports from their hypothesized model. Similarly, Byars-Winston and Fouad (2008) omitted person inputs and learning experiences from their model of college students' math/science career goals. In another study, Lent et al. (2003) omitted person inputs, background contextual affordances, and learning experiences from their structural model. Learning experiences and background contextual affordances were also omitted from a model in a more recent study in which the authors found support for the SCCT model (Byars-Winston et al., 2010). It may be that the testing of smaller SCCT models produces more theoretically consistent results due to reduced model complexity. However, Navarro et al. (2007) did find support for an extended SCCT model in a sample of Mexican American middle school students. It is also possible that omitting constructs which assume longitudinal relations (i.e., background contextual affordances, learning experiences) with criterion variables in SCCT reduces methodological error inherent in testing temporal assumptions with cross-sectional designs. Specifically, longitudinal studies may be more appropriate when testing associations between contextual and person-cognitive variables within an SCCT framework. Future research, such as meta-analyses, may also be beneficial to determine possible model-fit differences in studies testing extended and partial SCCT models.

Examination of past studies that have produced results supportive of the SCCT framework also reveals addition of parameters not always consistent with original SCCT hypotheses to improve model fit. For example, Ferry and Fouad (2000) added a path from background contextual affordances to math/science outcome expectations. Similar to the present study, this path improved model fit, but was not an original SCCT hypothesis. Instead, background contextual affordances were proposed to be fully mediated by learning experiences in the original theory (Lent et al., 2000).

Byars-Winston and Fouad (2008) also added a direct path to their model extending from background contextual affordances to math/science goals again suggesting that background contextual variables might be partially instead of fully mediated by person-cognitive variables. In another study, Byars-Winston et al. (2010) added a path from proximal contextual supports (i.e., perceived campus climate) to person inputs (i.e., ethnic identity). While the authors defended this addition as consistent with prior research on the two specific constructs under investigation, it should be noted the directional relationship was still inconsistent with original SCCT propositions (Lent et al., 2000). Future research is warranted to determine if SCCT constructs are fully mediated as initially proposed or partially mediated as seems to be suggested by past studies. Results of past studies in addition to the current study in which additional parameters were added may also be statistical artifact, as the addition of parameters often results in improved model fit (Kline, 2005).

Results of the present study should also be considered in light of sample characteristics. The sample for this study was more racially/ethnically diverse than some past SCCT studies using predominantly White samples (e.g., Byars-Winston & Fouad, 2008; Lent et al., 2003; Lent et al., 2008). Furthermore, no past studies using SCCT to predict students' math/science goal intentions have used samples consisting of all low-income or prospective first generation college students. Only one located study, in which the students were described as "85-95%...low socioeconomic status" (Fouad & Smith, 1996, p. 340), contained a comparable sample. Furthermore, few prior studies have used SCCT to explain the math/science goal intentions of high school students. Instead, most studies have included middle school or college students (e.g., Fouad & Smith, 1996; Navarro et al., 2007; Lent et al., 2003, 2005, 2008). Prior studies using high school students that have found support for the SCCT model have been outside the U.S. (Lent et al., 2010). It is possible that the SCCT model does not adequately describe the math/science career development process for U.S. students at the high school developmental period. For example, perhaps as students at this developmental stage begin to struggle with autonomy versus dependence, the influence of environmental factors becomes more or less salient for different individuals.

It is also notable that all participants in the present study were actively participating in federal TRIO programming. While Upward Bound Math-Science students were not included in this investigation, potential contamination effects based on participants' prior experience could have affected the internal validity of the study. For example, Upward Bound programs commonly place students with mentors who can guide the student toward higher education and more prestigious career goals (U.S. Board of Education, 2007b). It could be that the structure of TRIO program activities for this study's participants influenced the degree to which the SCCT model fit their math/science career development. For example, it may be that proximal supports (e.g., a mentor) experienced by students in this study had a direct effect on their learning experiences (e.g., showing them what someone who studies math and science does in a career). While this path is not hypothesized in the SCCT framework, it could be argued that it exists for the sample included in this study. Indeed, examination of residuals from the path analysis suggested that this path could have been added to the model in the present study.

In sum, the unique demographic and background characteristics of the sample in this study may account for discrepancies seen in the results of this and previous studies. Future research using ethnically diverse as well as less economically and educationally privileged students is warranted to ensure SCCT does or does not adequately explain the math/science goal intentions of high school students from these respective groups.

Hypothesis two—that perceptions of proximal supports would moderate the relationship between interests and goals—was also not supported in this study. This finding is consistent with prior research in which supports did not moderate the relation between interests and goals (Lent et al., 2001). With the exception of this research, no other located studies have investigated the moderating role of supports within the SCCT model. Results of this study and prior research suggest that proximal supports do not moderate the association between career interests and goals as initially proposed (Lent et al., 2000). Future research is necessary to support or disconfirm these findings. Additional studies could also investigate how various forms of support buffer or enhance the relationship between interests and goals.

Additionally, this study used a general measure of support to assess the proximal supports construct. It is possible that use of a more specific measure of proximal supports would have yielded different outcomes. Specifically, it may be that some forms of support have a greater impact than others and that a general measure of perceived support does not sufficiently capture the construct. From a practical perspective, it would also be helpful for clinicians, teachers, and administrators to be aware of more specific forms of support and how they affect career decision-making processes.

Hypothesis three stated that the relations between proximal supports, parental support, academic motivation and math/science goals would be mediated by core social cognitive variables (i.e., learning experiences, self-efficacy, outcome expectations, and interests). Results of bootstrapping procedures supported this hypothesis. However, these results should be taken with caution, as overall model fit in the present study was not supported. While all direct and indirect paths appeared to be significant, the data suggested that directional relations between variables did not follow SCCT propositions. Therefore, it is unclear if these mediation effects are generalizable or are statistical artifact.

Prior research has produced converse results in which model fit was acceptable, but some mediation tests were non-significant (Fouad & Smith, 1996). As with SCCT's moderator hypotheses, mediation hypotheses proposed by SCCT have not received as much empirical attention as has overall model fit. Given inconsistencies in prior research and findings presented in this study, future studies should explicitly test mediator and moderator hypotheses to provide more complete assessments of SCCT's viability as a theoretical framework. Importantly, longitudinal studies are needed to test mediation hypotheses between background contextual and person-cognitive variables in SCCT. For example, a cross-lagged panel design could be used to test relations between gender, self-efficacy, and interests. Mediation tests conducted in longitudinal designs would present more accurate tests of some theoretical assumptions in SCCT.

Implications for practice and policy. Results of this study provide mixed support for use of the SCCT framework to describe the math/science goals intentions of low-income, prospective first generation college students. Individuals working with low-income, prospective first generation college students should take results of this study into consideration before basing math/science career interventions on the SCCT theoretical model. Findings from this research suggest that all variables included in this study may be important factors to consider in promoting the math/science career goals of low-income, prospective first generation college students but do not necessarily relate as originally hypothesized within this population (Lent et al., 1994; Lent et al., 2000).

Therefore, practitioners and administrators may consider including all variables examined in this study in future interventions, but should not anticipate directional relations proposed in SCCT to take shape. For example, results of this study do not support the notion that encouraging parental support in math and science for low-income students with necessarily lead to future math/science career goal-setting via an increase in math/science self-efficacy. Similarly, this study's findings do not support the notion that proximal supports enhance the math/science interests of prospective first generation college students through increases in math/science self-efficacy.

Results of the present study also do not support the use of proximal supports to enhance the relationship between low-income, prospective first generation college students' interests and goals in math and science. It may be that other factors, not captured by the variables used in this study, account for potential discrepancies observed between students' interests and goals in math and science. As mentioned previously, it may be that more specific forms of supports or barriers account for these potential discrepancies than those represented in this study. For example, it has been proposed that social stigma associated with math and science performance in the U.S. may account for observed trends in the decline of math/science interests and goals over time (Anderegg, 2007). Inclusion of other culture-centered support variables such as a racially/ethnically matched mentor might also be a future area of exploration.

Results of this study, however, should not be interpreted as indicative that proximal supports among low-income prospective first generation college students are not necessary. Conversely, proximal supports exhibited significant relationships with all core social cognitive variables in the present study, suggesting they are important in the development of math/science career goals within this population. Examples of proximal supports could include development of mentorship programs and training school counselors on how to support or encourage students from less privileged backgrounds to pursue math/science academic and career goals. It is notable that TRIO programs implementing similar interventions as those suggested here have exhibited positive effects (U.S. Department of Education, 2007b).

Similarly, results of this study indicate that practitioners and administrators should make efforts to encourage parental support for math/science pursuits and enhance students' internal academic motivation for math and science. While not directionally related as hypothesized, these variables exhibited statistically significant relationships with other core social cognitive factors in this study. Promoting parental support for students in math and science could include development of parent meetings within federal TRIO programs or at the local high school level. Instructions to parents in these meetings could reflect items included on the parental support measure included in this study (e.g., encourage parents to support their children when they express interest in math/science activities; encourage parents to stress the importance of gaining skills and knowledge in math/science domains).

Facilitating students' internal motivation to learn about and pursue math/science endeavors also deserves attention based on previous research and results of this study. Practitioners and administrators should include learning activities in programming and classrooms that facilitate internal instead of external motivation to learn math and science. Specifically, learning activities could be structured such that they relate to students' lived experience and enhance their understanding of the personal importance of learning math and science. Connecting math and science to the activities associated with specific career paths students' may express interest in could also prove to be an effective method of promoting internal academic motivation in math and science.

Implications for research. Results of this study hold several implications for future research. First, additional studies are needed to determine whether the SCCT model is indeed not an adequate representation of the math/science career goals of low-income, prospective first generation college students. While not supported in this study, results of additional research could clarify whether the poor fit of the SCCT model for the sample included in this study is generalizable or statistical artifact. Future studies could use different constructs than those used in the present investigation to represent contextual SCCT variables. It may be that results in the present investigation were affected due to the inclusion of the specific environmental factors (i.e., parental support, academic motivation, general proximal supports) and that other environmental factors not included in this research would improve fit of the SCCT model for this population. Specifically, other person inputs such as subjective social class or personality could be included in future research. Similarly, alternative and more specific proximal supports such as parents, teachers, or counselors could be included in future studies. Results of these studies could help identify which particular supports are most meaningful to students in their math/science academic and career development.

More research is also needed to determine if proximal supports and barriers do indeed moderate the relations between interests and goals as hypothesized by Lent and colleagues (2000). No located studies have supported this assertion and the only other study to investigate this relation found no support for the hypothesis (Lent et al., 2001). It is important that more research is conducted to examine this proposition before it is accepted as valid within SCCT. Again, specificity could be an issue here, as matching specific perceived supports and barriers to the population under investigation might impact study results. Anticipating sex discrimination, for example, might be more likely to buffer the relation between interests and goals for women interested in engineering more so than men. While this study focused on supports, more studies using SCCT are needed that investigate proximal barriers as well as supports and barriers concomitantly. This line of research could provide information regarding whether practitioners should focus on providing supports, eliminating barriers, or both.

Additional studies are also needed that examine mediation hypotheses put forth in SCCT. Results of this study were mixed, as bootstrapping tests suggested mediated relationships between contextual factors and math/science goals, but overall model fit statistics indicated poor fit of the hypothesized structural model. Few research studies using SCCT have explicitly examined mediation hypotheses and those that have, frequently used outdated methods of testing mediation or overall SEM model fit statistics to determine support for directional SCCT propositions (e.g., Fouad & Smith; Lent et al., 2003). Furthermore, previous researchers appear to have frequently engaged in post-hoc model specification to improve overall model fit statistics (e.g., Byars-Winston & Fouad 2008) which is not consistent with recommendations for conducting SEM (Martens, 2005) or theoretical assumptions of SCCT (Lent et al., 1994, 2000). Future meta-analyses could examine results of studies adding paths inconsistent with SCCT and those that have not to determine if partially mediated relationships might better explain relations between SCCT constructs.

Additional studies testing the full SCCT model are also warranted. While assessing all SCCT constructs could present researchers with potential difficulties in terms of survey length and construct specification, these studies could shed light on whether directional relations between all variables specified in SCCT can be empirically supported. Consistent with this recommendation, longitudinal research is sorely needed that assesses the temporal relations between SCCT constructs. Specifically, the longitudinal relations between background contextual affordances and later person-cognitive variables such as interests, should be examined. This line of research could substantiate relationships suggested, but less directly testable by cross-sectional designs using SCCT, such as the relation between gender and math/science career goals. Similarly, the depiction of proximal supports and goals in SCCT suggests a temporal relationship between these two constructs. However, most studies have not used longitudinal designs to examine this relationship.

Finally, more intervention and experimental studies are needed to determine causality within the SCCT framework. For example, does manipulating math/science self-efficacy lead to a change in math/science outcome expectations? Similarly, does providing students with college mentors cause a change in math/science self-efficacy? This form of research could more clearly demonstrate the need for points of intervention suggested within the SCCT model.

Limitations. There are several notable limitations to the present study. First, a cross-sectional design was used which does not allow for inference of causality or temporal relations between variables. Although measures in the present study generally exhibited adequate psychometric properties, only single indicators for constructs were used. Some authors have recommended using multiple instruments to represent constructs in studies using SEM to improve measurement and model fit (Kline, 2005). Therefore, potential bias in measurement could have impacted study results. Additionally, no measure of social desirability was used in the present investigation, leaving speculation as to whether response bias may have influenced study results. Finally, some of the instruments included in the present study were had not been validated with high school students and subscale scores for math and science self-efficacy on the ESCI-HS were combined to produce a single indicator of math/science self-efficacy. It is possible that measures developed and validated with high school students would have produced different results or that results may have differed had math and science self-efficacy been treated as independent observed variables. For example, the path from learning experiences may have been stronger for math than science self-efficacy, suggesting learning experiences are particularly important in this academic domain.

Furthermore, participants all attended federal TRIO programs in the Midwestern U.S., which limits the generalizability of study results. That is, it is unclear whether results of this study would extend to students who are not low-income prospective first generation college students in geographical regions outside the Midwest. Selection issues may have also limited generalizability in the present study, as participants' parents enrolled their children in the TRIO programs used as sites for data collection. Students from such families may experience more contextual supports from family and teachers compared to their peers. Although post-hoc analyses revealed there was sufficient power to detect large and medium effect sizes between European American, African American, Asian American, and Latina/o students on variables of interests in this study, achieved power to detect small effect sizes was relatively limited (power = .52). Had a greater number of participants for each racial/ethnic group been obtained, it is possible statistically significant differences between participants would have been observed. Furthermore, subgroups within racial/ethnic categories were collapsed, leaving no way to examine differences between subgroups of Latina/o and Asian American students.

Conclusion

Results of this study provide mixed support for use of the SCCT framework to describe the math/science career goals of low-income, prospective first generation college students. Although constructs included in this study were found to have significant relations with one another, the hypothesis that they would relate in ways consistent with SCCT was not supported. Methodological issues inherent in the present investigation may, in part, help explain these findings. Future theoretical and empirical work is necessary to determine what conceptual model(s) do explain these students' educational and career development in math and science. This research is greatly needed to develop interventions that can increase underrepresented students' participation in what will be a vital piece of the U.S. and global economies in years to come (NSB, 2010).

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Table 1.

Effect Sizes for SCCT Cognitive-Person Variables Reported in Prior Literature

Path	Effect Size
1. Self-efficacy → interests	.28
2. Outcome expectations → interests	.27
3. Interests → goals	.36
4. Goals → activity selection/practice	.06
5. Activity selection/practice → performance	.11
6. Learning experiences → self-efficacy	.14
7. Learning experiences → outcome expectations	.01
8. Self-efficacy → outcome expectations	.24

Note. Values reported in Lent et al. (1994). All effect sizes are reported as r^2.

Table 2.

Means, Standard Deviations, and Intercorrelations of Main Study Variables

Variable	M	SD	Possible Range	1	2	3	4	5	6	7	8
1. LE	3.60	0.81	1-5	___	.57	.57	.51	.37	.47	.28	.43
2. MSI	3.62	1.11	1-6		___	.64	.62	.40	.28	.44	.38
3. MSIGS	4.13	1.24	1-5			___	.51	.43	.30	.48	.30
4. MSSE	3.37	0.82	1-5				___	.39	.26	.45	.35
5. OE	7.01	1.60	0-9					___	.31	.27	.34
6. Parent Support	3.50	0.71	1-5						___	.16	.36
7. RAI	0.54	1.05	-2-6							___	.29
8. Supports	3.70	0.85	1-5								___

Note. All correlations above .20 are significant at the .001 level. Correlations below .20 are significant at the .01 level. LE = learning experiences. MSI = math/science interests. MSIGS = math/science interests and goals. MSSE = math/science self-efficacy. OE = outcome expectations. RAI = relative autonomy index. Supports = proximal supports.

Table 3

Goodness-of-Fit Indicators for the Nested Path Models

Model	χ^2/df	CFI	IFI	TLI	RMSEA	90% CI for RMSEA
A	14.82	.75	.75	.54	.21	(0.18, 0.23)
B	11.41	.73	.74	.56	.18	(0.16, 0.20)
C	**12.19**	**.86**	**.87**	**.63**	**.19**	**(0.16, 0.22)**

Note. CFI = comparative fit index; IFI = incremental fit index; TLI = Tucker-Lewis index; RMSEA = root-mean-squared error approximation; Model A = the proposed hypothetical model; Model B = direct paths from proximal supports to interests and goals; Model C = added paths from academic motivation to math/science self-efficacy, parent support to outcome expectations, and learning experiences to interests. Bold indicates the best model.

Table 4.

Summary of Indirect Effects

	Bootstrap estimates		
Path/effect	Mean *B*	Mean *SE*	95% CI
PRS→MSSE→MSI→MSIGS	.11	.04	.038, .205**
RAI→LE→MSSE→MSI→MSIGS	.09	.02	.056, .205*
PAS→LE→OE→MSI→MSIGS	.21	.04	.133, .313**

Note. Estimates of indirect effects are based on standardized coefficients. PRS = proximal supports, MSSE = math/science self-efficacy, MSI = math/science interests, MSIGS = math/science interests and goals, RAI = relative autonomy index, LE = learning experiences, OE = outcome expectations, PAS = parental support.
*$p < .01$. **$p < .001$

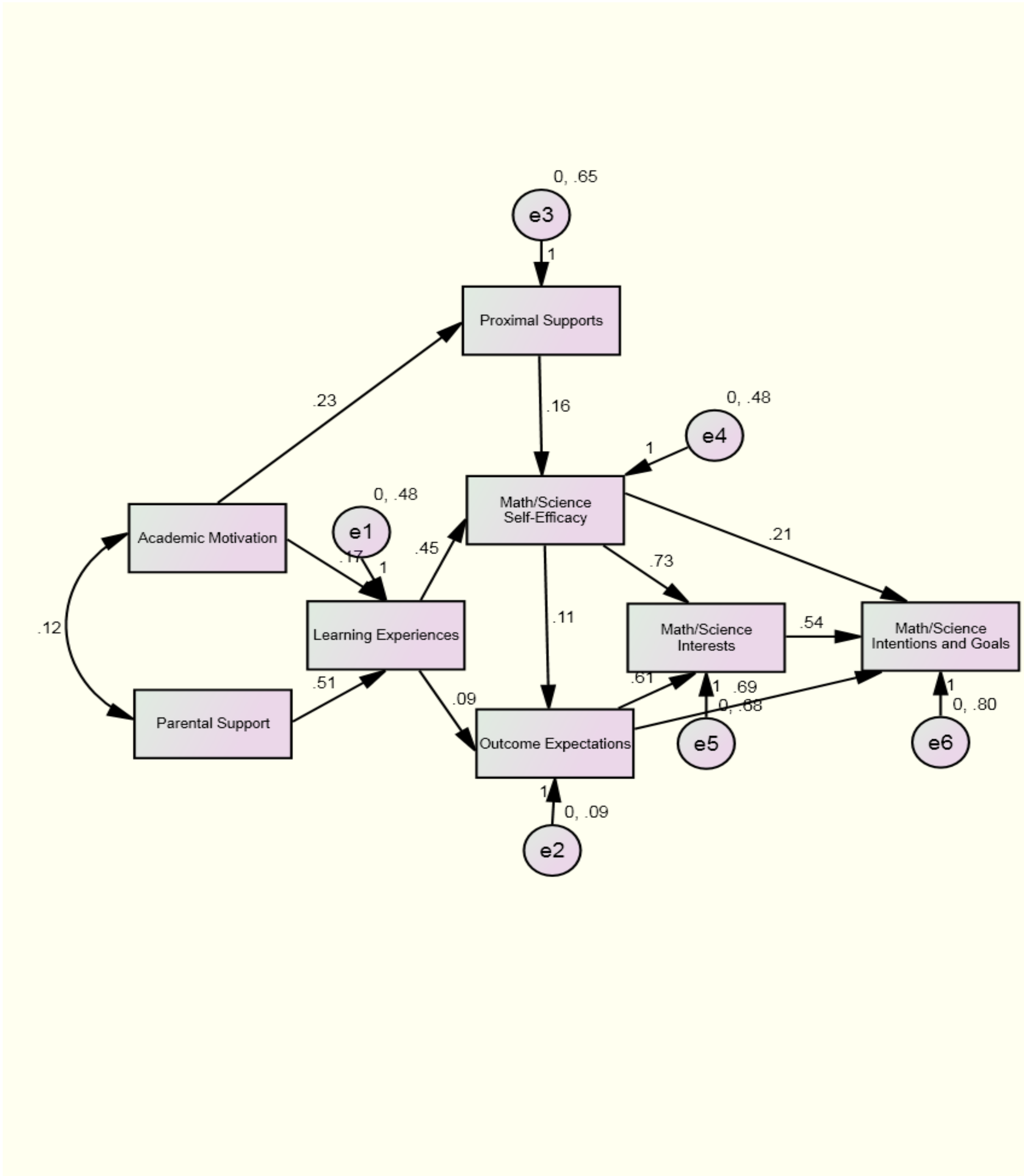

Figure 1. Hypothesized indirect effects model (Model A). All paths above .10 are significant at the .001 level. All paths below .10 are significant at the .01 level.

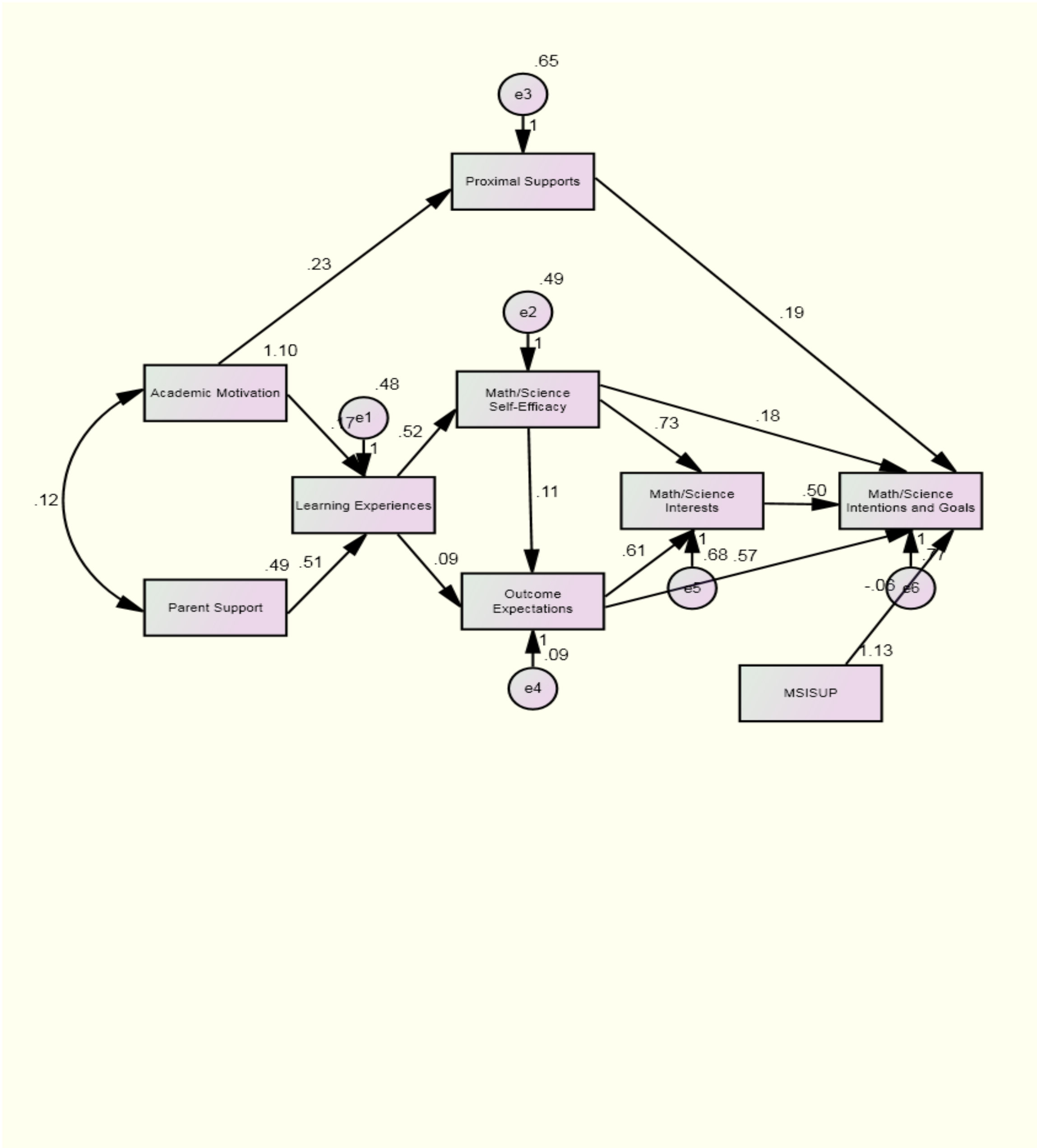

Figure 2. Results of direct effects model (Model B). All paths above .10 are significant at the .001 level. Path from learning experiences to outcome expectations is significant at the .01 level. Paths in bold are not significant.

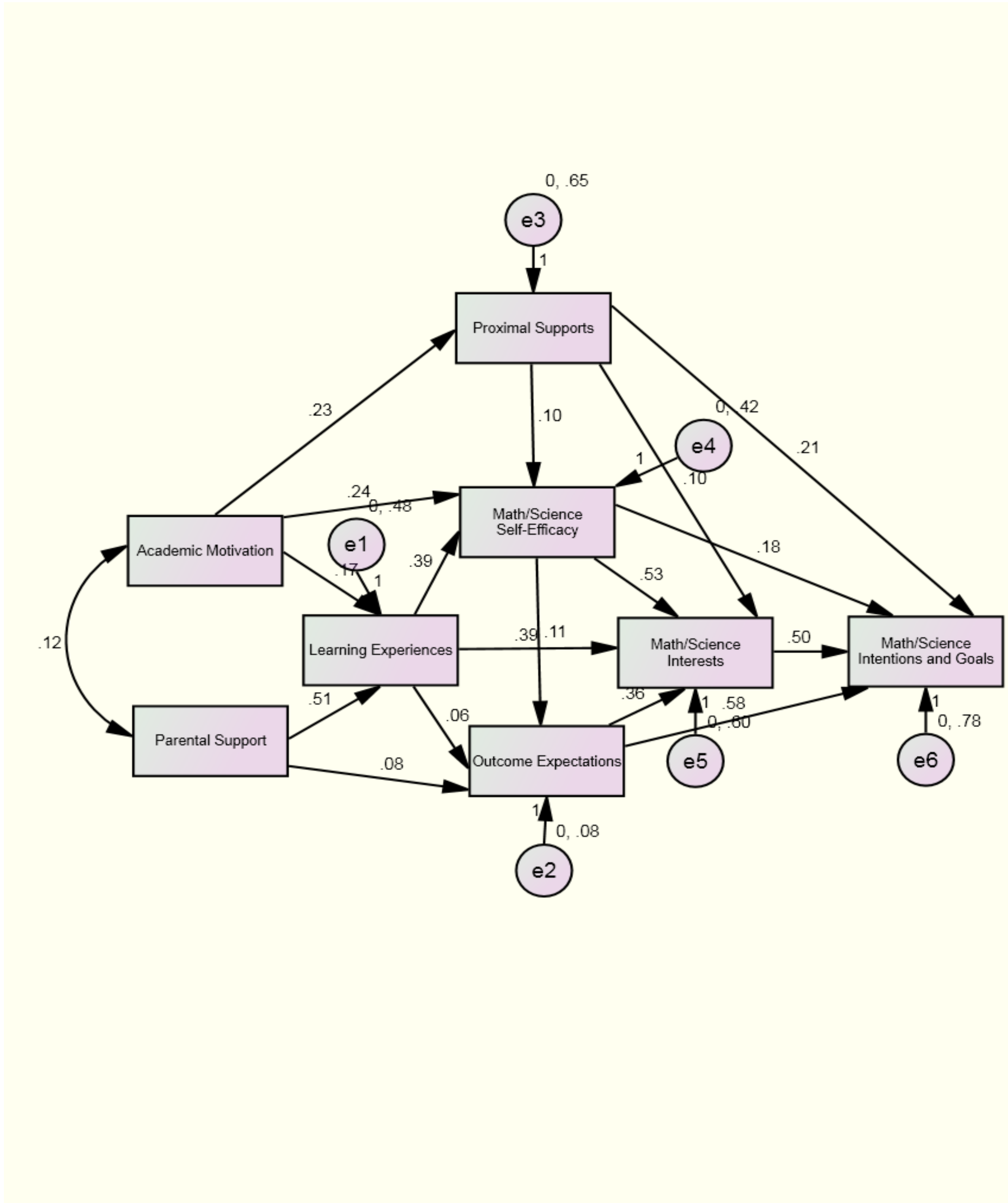

Figure 3. Alternative model (Model C) tested in the present study. Paths between proximal supports and math/science self-efficacy and math/science interests are not significant ($p > .05$). Remaining paths are significant at the .05 level.

Appendix A

Demographic Questionnaire

Directions: The following are some questions about you and your family. Please fill in OR circle the best description of you and your family members.

1. Your Age _________

2. Your Sex:
- a. Female
- b. Male

3. Your Race/Ethnicity:
- a. Hispanic (please specify):
  - Mexican American_____
  - South American____
  - Spanish American____
  - Puerto Rican American____
  - Cuban American____
  - Central American____
- b. White (non-Hispanic) _____
- c. African American_____
- d. Asian American (please specify your ethnic heritage): ____________________
- e. Native American_____
- f. Biracial/Multiracial_____ (please specify)________________________
- g. Other (please specify)_________________

4. What is your current grade level?
- a. Freshman
- b. Sophomore
- c. Junior
- d. Senior

5. Are you eligible for free lunch?
- a. yes
- b. no

6. Are you eligible for reduced lunch?
- a. yes
- b. no

7. For *all* the people that live in your home, please provide the following information: their ages; their relationship to you; and their current (or most recent) job held. For example, mother, father, sister, brother, aunt, uncle, grandmother, cousin, foster-parent, stepparent, or non-relative.

Relationship to you	Age	Current (or most recent) job held
Example: Mother	38	Homemaker/does not work
Brother	14	9th grade student
______________________________	_________	______________________________
______________________________	_________	______________________________
______________________________	_________	______________________________
______________________________	_________	______________________________
______________________________	_________	______________________________
______________________________	_________	______________________________
______________________________	_________	______________________________

______________________________ _________ ______________________________
______________________________ _________ ______________________________

8. Who is the female head of your household (e.g., the adult woman who provides for you in terms of food, housing, clothing, and other resources)?

a. your mother
b. your step-mother
c. your sister
d. your grandmother
e. your aunt
f. other (please specify_________________)

9. How much education did the female head of your household complete?

a. less than 7th grade
b. junior high (9th grade)
c. partial high school (10th or 11th grade)
d. high school graduate
e. partial college (1 year or more)
f. standard college or university graduate
g. graduate/professional degree (e.g., Master's, Ph.D., JD); specify:______________________

10. Who is the male head of your household? (e.g., the adult man who provides for you in terms of food, housing, clothing, and other resources)

a. your father
b. your step-father
c. your brother
d. your grandfather
e. your uncle
f. other (please specify____________________)

11. How much education did the male head of your household complete?

a. less than 7th grade
b. junior high (9th grade)
c. partial high school (10th or 11th grade)
d. high school graduate
e. partial college (1 year or more)
f. standard college or university graduate
g. graduate/professional degree (e.g., Master's, Ph.D., JD); specify:______________________

12. Do you have access to the following items at your home? Please answer yes or no to <u>each</u> item.

a. computer Yes_____ No_____
b. atlas/maps/globe Yes_____ No_____
c. dictionary Yes_____ No_____
d. encyclopedia Yes_____ No_____

13. What was your OVERALL math grade during the previous school year?
For example, if you are now a senior, what was your OVERALL math grade for your junior year?

a. A (93-100)
b. A- (90-92)
c. B+ (87-89)
d. B (83-86)
e. B- (80-82)
g. C (73-76)
f. C+ (77-79)
h. C- (70-72)
i. D+ (67-69)
j. D (63-66)
k. D- (60-62)
l. F (Below 59)

14. What was your OVERALL science grade during the previous school year?
For example, if you are now a senior, what was your OVERALL math grade for your junior year?

a. A (93-100)
b. A- (90-92)
c. B+ (87-89)
d. B (83-86)
e. B- (80-82)
g. C (73-76)
f. C+ (77-79)
h. C- (70-72)
i. D+ (67-69)
j. D (63-66)
k. D- (60-62)
l. F (Below 59)

15. Think of these numbers as a ladder representing where people stand in society. At the top of the ladder are the people who are best off – those who have the most money. At the bottom are those who are worst off – those who have the least money, least education and the worst jobs or no job. The higher up on this ladder, the closer you are to people at the very top and the lower you are, the closer you are to the bottom. Where would you put your family on the ladder? Please mark the number indicating where you think your family stands.

10_____
9_____
8_____
7_____
6_____
5_____
4_____
3_____
2_____
1_____

16. Please indicate the highest level of education you plan to pursue.

a. partial high school (10th or 11th grade)
b. high school graduate
e. partial college (1 year or more)
f. standard college or university graduate
g. graduate/professional degree (e.g., Master's, Ph.D., JD);
specify:_______________________
≈

Appendix B

Math/Science Goals Scale
Fouad & Smith (1999)

Instructions: Please indicate the degree to which you agree or disagree with the statement below by circling the appropriate letters to the right of each statement.

How much do you agree or disagree with the following statements:	**Very Strongly Disagree**	**Mostly Disagree**	**Slightly Disagree**	**Slightly Agree**	**Mostly Agree**	**Very Strongly Agree**
1. I am committed to study hard in my math courses.	1	2	3	4	5	6
2. I plan to take more science courses in college than will be required of me.	1	2	3	4	5	6
3. I plan to take more math courses in college than will be required of me.	1	2	3	4	5	6
4. I am committed to study hard in my science courses.	1	2	3	4	5	6
5. I intend to enter a career that will use math.	1	2	3	4	5	6
6. I am determined to use my science knowledge in my future career.	1	2	3	4	5	6
7. I intend to enter a career that will use science.	1	2	3	4	5	6

Appendix C

Math/Science Interests
Fouad & Smith (1999)

Instructions: Please indicate the degree to which you agree or disagree with the statement below by circling the appropriate numbers to the right of each statement.

	Very Strongly Dislike	**Mostly Dislike**	**Slightly Dislike**	**Slightly Like**	**Mostly Like**	**Very Strongly Like**
1. Work as an astronomer.	1	2	3	4	5	6
2. Taking classes in science.	1	2	3	4	5	6
3. Visiting a science museum.	1	2	3	4	5	6
4. Listening to a famous scientist talk.	1	2	3	4	5	6
5. Solving computer problems.	1	2	3	4	5	6
6. Solving math puzzles.	1	2	3	4	5	6
7. Creating new technology.	1	2	3	4	5	6
8. Touring a science lab.	1	2	3	4	5	6
9. Joining a science club.	1	2	3	4	5	6
10. Reading about science discoveries.	1	2	3	4	5	6
11. Participating in a science fair.	1	2	3	4	5	6
12. Working in a science laboratory.	1	2	3	4	5	6
13. Working in a medical lab.	1	2	3	4	5	6
14. Inventing.	1	2	3	4	5	6
15. Watching a science program on TV.	1	2	3	4	5	6
16. Using a calculator.	1	2	3	4	5	6
17. Learning about energy and electricity	1	2	3	4	5	6
18. Working with plants and animals.	1	2	3	4	5	6
19. Taking classes in math.	1	2	3	4	5	6
20. Working with a chemistry set.	1	2	3	4	5	6

Appendix D

Expanded Skills Confidence Inventory—High School (ESCI-HS)
Betz & Wolfe 2005

Instructions: For each statement listed below, indicate how much confidence you have that you could accomplish each activity, task, or school subject. Use the following scale to indicate your level of confidence.

	No confidence at all	**Very little confidence**	**Moderate confidence**	**Much confidence**	**Complete confidence**
1. Calculate the dollar savings for an item on sale.	1	2	3	4	5
2. Determine the number of yards of carpet needed for a room.	1	2	3	4	5
3. Solve math word problems.	1	2	3	4	5
4. Reduce a recipe that serves 6 people to one that serves 2.	1	2	3	4	5
5. Calculate how long it will take to drive between two cities at 65 mph.	1	2	3	4	5
6. Compare the value of different size boxes of the same product at the grocery store.	1	2	3	4	5
7. Solve algebraic equations.	1	2	3	4	5
8. Calculate a shooting percentage in basketball.	1	2	3	4	5
9. Understand the scientific basis of a medical breakthrough.	1	2	3	4	5
10. Learn about the way a new medication works.	1	2	3	4	5
11. Learn about the origins of a species.	1	2	3	4	5

12. Learn different constellations and planets in the solar system.	1	2	3	4	5
13. Study the way the human mind works.	1	2	3	4	5
14.Write up the results of a chemistry experiment.	1	2	3	4	5
15. Pass a course in Biology.	1	2	3	4	5
16. Read and understand science magazines.	1	2	3	4	5

Appendix E

Math/Science Supports and Barriers
Lent et al. (2005)

Instructions: Many factors can either support or hinder a students' college and career plans. We are interested in learning about the types of situations that could help or hinder your plans if you were to pursue a career in a math or science field. For the questions below, assume that you wanted to pursue a math/science major. Using the 1-5 scale, show how likely you believe you would be to experience each of the following situations.

If you were to major in an engineering field, how likely would you be to…	**Not at All Likely**	**A Little Likely**	**Moderately Likely**	**Quite Likely**	**Extremely Likely**
1. Have access to a "role model" in this field (i.e., someone you can look up to and learn from observing)	1	2	3	4	5
2. Feel support for this decision from important people in your life (e.g., teachers)	1	2	3	4	5
3. Feel that there are people "like you" in this field	1	2	3	4	5
4. Get helpful assistance from a tutor, if you felt you needed such help	1	2	3	4	5
5. Get encouragement from your friends for pursuing this major	1	2	3	4	5
6. Get helpful assistance from your advisor	1	2	3	4	5
7. Feel that your family members support this decision	1	2	3	4	5
8. Feel that close friends or relatives would be proud of you for making this decision	1	2	3	4	5
9. Have access to a "mentor" who could offer you advice and encouragement	1	2	3	4	5
10. Receive negative comments or discouragement about your major from family members	1	2	3	4	5
11. Worry that such a career path would require too much time or schooling	1	2	3	4	5
12. Feel that you don't fit in	1	2	3	4	5

socially with other students in this major					
13. Receive negative comments or discouragement about your major from your friends	1	2	3	4	5
14. Feel pressure from parents or other important people to change your major to some other field.	1	2	3	4	5

Appendix F

Math/Science Outcome Expectations
Lent et al. (2003)

Instructions: Using the scale (0 to 9) below, please indicate the extent to which you agree or disagree with each of the following statements.

Graduating with a BS degree in a math or science major will likely allow me to:	**Strongly Disagree**		**Disagree**		**Unsure**		**Agree**		**Strongly Agree**	
1. … receive a good job offer	0	1	2	3	4	5	6	7	8	9
2. … earn an attractive salary	0	1	2	3	4	5	6	7	8	9
3. … get respect from other people	0	1	2	3	4	5	6	7	8	9
4. … do work that I would find satisfying	0	1	2	3	4	5	6	7	8	9
5. … increase my sense of self-worth	0	1	2	3	4	5	6	7	8	9
6. … have a career that is valued by my family	0	1	2	3	4	5	6	7	8	9
7. … do work that can "make a difference" in people's lives	0	1	2	3	4	5	6	7	8	9
8. … go into a field with high employment demand	0	1	2	3	4	5	6	7	8	9
9. … do exciting work	0	1	2	3	4	5	6	7	8	9
10. … have the right type and amount of contact with other people (i.e. "right" for me)	0	1	2	3	4	5	6	7	8	9

Appendix G

Learning Experiences Questionnaire
(Schaub, 2003)

Instructions: Using the following scale, write the number corresponding to your response on the line next to the statement. Please respond to ALL of the statements.

How much do you agree or disagree with the following statements:	**Strongly Disagree**	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
1. I performed well in biology courses in school.	1	2	3	4	5	6
2. People whom I respect have encouraged me to work hard in math courses.	1	2	3	4	5	6
3. I have become nervous while solving math problems.	1	2	3	4	5	6
4. I was successful performing science experiments in school.	1	2	3	4	5	6
5. In school, I saw teachers whom I admired work on science projects.	1	2	3	4	5	6
6. I remember my family telling me that it is important to be able to solve science problems.	1	2	3	4	5	6
7. People whom I looked up to told me that it is important to read scholarly articles.	1	2	3	4	5	6
8. I received high scores on the math section of my college entrance exam (e.g., SAT, ACT).	1	2	3	4	5	6
9. While growing up, I saw people I respected using math to solve problems.	1	2	3	4	5	6
10. I have felt anxious while taking a science course in school.	1	2	3	4	5	6
11. I have seen people	1	2	3	4	5	6

whom I respect participating in activities that require math abilities.						
12. I recall seeing adults whom I admire working in a research laboratory.	1	2	3	4	5	6
13. I have felt uneasy while learning new topics in biology courses.	1	2	3	4	5	6
14. I have easily understood new math concepts after learning about them in class.	1	2	3	4	5	6
15. I have demonstrated skill at conducting research for my term papers.	1	2	3	4	5	6
16. Reading scientific articles has made me feel uneasy.	1	2	3	4	5	6
17. I have felt dread while using math in a job.	1	2	3	4	5	6
18. While growing up, I recall seeing people I respected reading scientific articles.	1	2	3	4	5	6
19. My friends have encouraged me to use my research abilities.	1	2	3	4	5	6
20. Teachers whom I admire have encouraged me to take science courses.	1	2	3	4	5	6

Appendix H

Reasons for Learning Questionnaire
Williams & Deci (1996)

Instructions: The following questions relate to your reasons for participating actively in your math and science classes. Different people have different reasons for their participation in such classes, and we want to know *how true* each of the reasons is for you. Please use the following scale to indicate how true each reason is for you:

A. I will participate actively in math/science classes because:	**Not at all true**			**Somewhat true**			**Very true**
1. I feel like it's a good way to improve my understanding of the material.	1	2	3	4	5	6	7
2. Others might think badly of me if I didn't.	1	2	3	4	5	6	7
3. I would feel proud of myself if I did well in the course.	1	2	3	4	5	6	7
4. A solid understanding of math and science is important to my intellectual growth.	1	2	3	4	5	6	7
B. I am likely to follow my instructor's suggestions for studying math/science because:	**Not at all true**			**Somewhat true**			**Very true**
5. I would get a bad grade if I didn't do what he/she suggests.	1	2	3	4	5	6	7
6. I am worried that I am not going to perform well in the course.	1	2	3	4	5	6	7
7. It's easier to follow his/her suggestions than come up with my own study strategies.	1	2	3	4	5	6	7
8. He/she seems to have insight about how to best learn the material.	1	2	3	4	5	6	7
C. The reason that I will work to expand my knowledge of math/science is because:	**Not at all true**			**Somewhat true**			**Very true**
9. It's interesting to learn more about math and science	1	2	3	4	5	6	7
10. It's a challenge to really understand how to solve math/science problems.	1	2	3	4	5	6	7

11. A good grade in math or science would look positive on my record.	1	2	3	4	5	6	7
12. I want others to see that I am intelligent.	1	2	3	4	5	6	7

Appendix I

Fennema-Sherman Math Attitudes Scale (1976)

Instructions: Using the scale (1 to 5) below, please indicate the extent to which you agree or disagree with each of the following statements.

	Strongly Disagree	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly Agree**
1. My mother has encouraged me to do well in mathematics.	1	2	3	4	5
2. My mother has always been interested in my progress in mathematics.	1	2	3	4	5
3. My father has always been interested in my progress in mathematics.	1	2	3	4	5
4. My father thinks I could be good in math.	1	2	3	4	5
5. My mother thinks I could be good in math.	1	2	3	4	5
6. My father has strongly encouraged me to do well in mathematics.	1	2	3	4	5
7. My father wouldn't encourage me to plan a career which involves math.	1	2	3	4	5
8. My mother wouldn't encourage me to plan a career which involves math.	1	2	3	4	5
9. My mother has strongly encouraged me to do well in science	1	2	3	4	5
10. My father has always been interested in my progress in science.	1	2	3	4	5
11. My father thinks I could be good in science.	1	2	3	4	5
12. My mother thinks I could be good in science.	1	2	3	4	5
13. My father has strongly encouraged me to do well in science.	1	2	3	4	5
14. My father wouldn't encourage me to plan a career which involves science.	1	2	3	4	5
15. My mother wouldn't encourage me to plan a career which involves science.	1	2	3	4	5
16. My mother has strongly encouraged me to do well in science.	1	2	3	4	5

VITA

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