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Success in the sciences: potential influences of sex role conflict, self-efficacy, and role modeling on women's career aspirations

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Success in the sciences: Potential influences of sex role conflict, self-efficacy, and role modeling on women's career aspirations

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ABSTRACT

A discrepancy exists between the number of men and women pursuing careers in science, technology, engineering, and mathematics (STEM). To investigate this discrepancy, this study examined a model assessing the potential influence of multiple variables on the career aspirations of women pursuing these degrees. Two hundred thirty-two first and second-year women majoring in STEM fields completed measures assessing quality and quantity of role modeling relationships, STEM self-efficacy, STEM interests, sex role conflict, and career aspirations. Quality of role modeling relationships and STEM self-efficacy significantly predicted career aspirations. STEM self-efficacy did not mediate the relation between quality of role modeling relationships and career aspirations. Findings highlight the importance of role modeling relationships and STEM self-efficacy for women pursuing careers in STEM fields.

CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

Although women currently comprise more than half of college graduates, a careful examination of the prevalence of women pursuing careers in science, technology, engineering, and mathematics (STEM) fields reveals a much smaller proportion of women than men. According to the National Science Foundation's 2002 report, women made up only 47% of those earning mathematics degrees, 46% of chemistry degrees, 43% of agricultural science degrees, 38% of earth science degrees, 33% of chemical engineering degrees, and 27% of computer science degrees in 1998. Additionally, women constituted less than 20% of those earning bachelor's degrees in mechanical engineering, electrical engineering, aerospace engineering, and physics (National Science Foundation, Division of Science Resources Statistics [NSF/SRS], 2002). These proportions fell short, considering the fact women earned 60% of all non-science and engineering bachelor's degrees at that time. Although the number of STEM degrees earned by women has been rising slowly but steadily over the years (NSF/SRS, 2007), the percentage of women earning degrees in STEM fields, especially computer science, engineering, and physics, continues to lag behind the percentage of men.

Lubinski, Benbow, Shea, Eftekhari-Sanjani, and Halvorson (2001) reported a much lower proportion of women than men in engineering and physical science doctoral programs, despite a great amount of federal funding to reduce this gap. In 2004, women accounted for only 22% of engineering graduate students and 27% of computer science graduate students (NSF/SRS, 2007). These small percentages translate to equally disproportionate employment statistics. NSF's 2002 report revealed women constituted only 24% of those employed in a science or engineering-related field in 1999. This proportion becomes more striking when one considers that the fields of psychology and sociology/anthropology, which are composed primarily of women (64% and 52%, respectively, in 1999), were represented in this sample. In contrast, only 16% of chemical engineers, 10% of physicists/astronomers, 6% of electrical engineers, and 6% of mechanical engineers were female at this time (NSF/SRS, 2002). Four years later, the percentage of those employed in a science or engineering-related field had risen to 27%, with women accounting for 20% of chemical engineers, 11% of physicists/astronomers, 10% of electrical engineers, and 7% of mechanical engineers (NSF/SRS, 2007). Over the past few decades, women have begun earning more science and engineering degrees, yet these proportions remain deficient in many crucial areas (NSF/SRS, 2007). These discrepancies lead one to wonder why more women are not pursuing prestigious, rewarding careers in science, technology, engineering, and mathematics.

When exploring the causes of women's significantly lower involvement in STEM disciplines, one must take into account a variety of factors. Many influences impact career decision-making processes, such as one's experiences with the subject matter, natural abilities, interests, self-efficacy, perceptions of role conflict, amount of received encouragement/support, and general employment practices. Sax and Bryant (2006) found support for the impact of these variables in their longitudinal examination of factors contributing to the career choices of men and women. These researchers cited self-confidence in mathematics, tendencies toward high achievement, and commitment to achieving in science as significant predictors of women's decisions to pursue a non-traditional occupational field. Men selecting nontraditional career paths tended to have lower mathematics self-confidence, lower drives to achieve, and more egalitarian views regarding gender roles than men in traditionally male fields. As one can observe from the research literature, multiple variables influence the development of one's vocational choices. Researchers have studied these potential predictors to a great degree over the past few decades, resulting in the development of two dominant theoretical models typically utilized to account for vocational choices (Lent, Brown, & Hacket, 1994; Eccles, 1987).

Social Cognitive Career Theory (SCCT), developed by Lent, Brown, and Hackett (1994), states that individual variables, such as natural abilities and traits, impact one's learning experiences (see Figure 1). These experiences shape self-efficacy beliefs and outcome expectations. Working together, these components determine interest development, subsequently influencing goals like educational and career aspirations. These goals, along with contextual influences, impact choice actions. Choice actions affect performance attainments, which lead to new learning experiences. In short, SCCT seeks to explain the complex combination of one's personality traits, abilities, experiences, self-efficacy beliefs, expectations, and interests, which all lead to the development of an individual's career goals and aspirations.

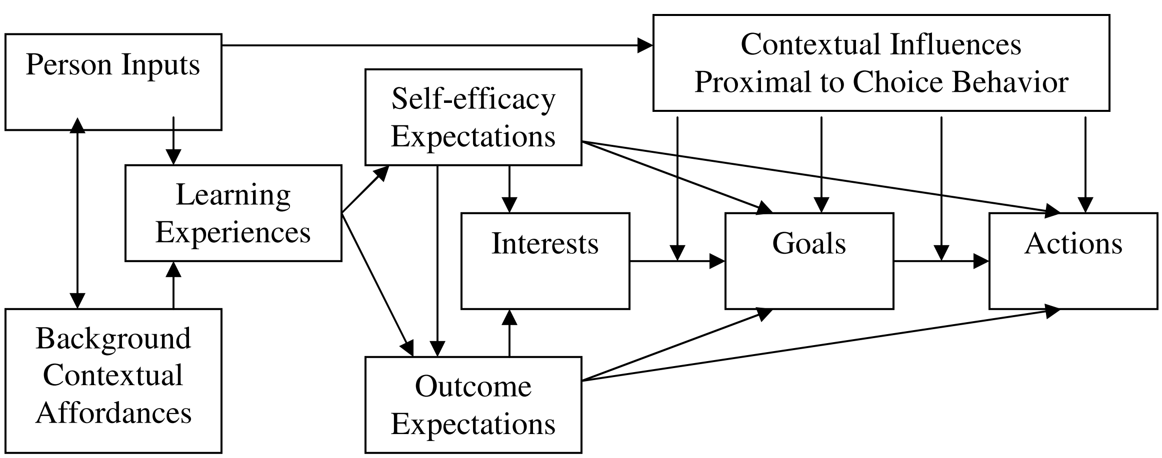

Figure 1. Model of social cognitive influences on career choice behavior (Lent, Brown, & Hackett, 1994).

Eccles (1987) proposed a slightly different model to explain educational and occupational choice (see Figure 2). This model focuses on achievement-related choices, as opposed to SCCT's general explanation of career-related choices. According to Eccles' model, one's experiences, abilities, and environmental components (i.e., the cultural milieu) impact the individual's perceptions of gender roles, stereotypes, and their interpretation of experiences. One's perceptions and interpretations of experiences combine to shape one's goals and general self-schemata. Interpretations of experiences also impact one's affective memories of those experiences. These affective memories, goals, and self-schemata come together to shape an individual's subjective value of a task, which leads to achievement-related choices. One's goals and self-schemata lead to the expectation of success, which also impacts achievement-related choices. This model provides a complex perspective of the process involved in women's choices related to achievement. Although developed before other models of choice behavior, it pulls together a multitude of characteristics described by its successors: experiences, abilities, gender role stereotypes, influence of a socializer (i.e., role model), goals, perceptions of one's abilities, expectations of success (i.e., self-efficacy), and choice behaviors. Both of these models complement each other, therefore supporting their generalizability to explaining career-related behavior. These models also emphasize the complex interplay of a wide array of individual characteristics, which must be taken into account to describe women's career-related choice behavior and their development of professional aspirations.

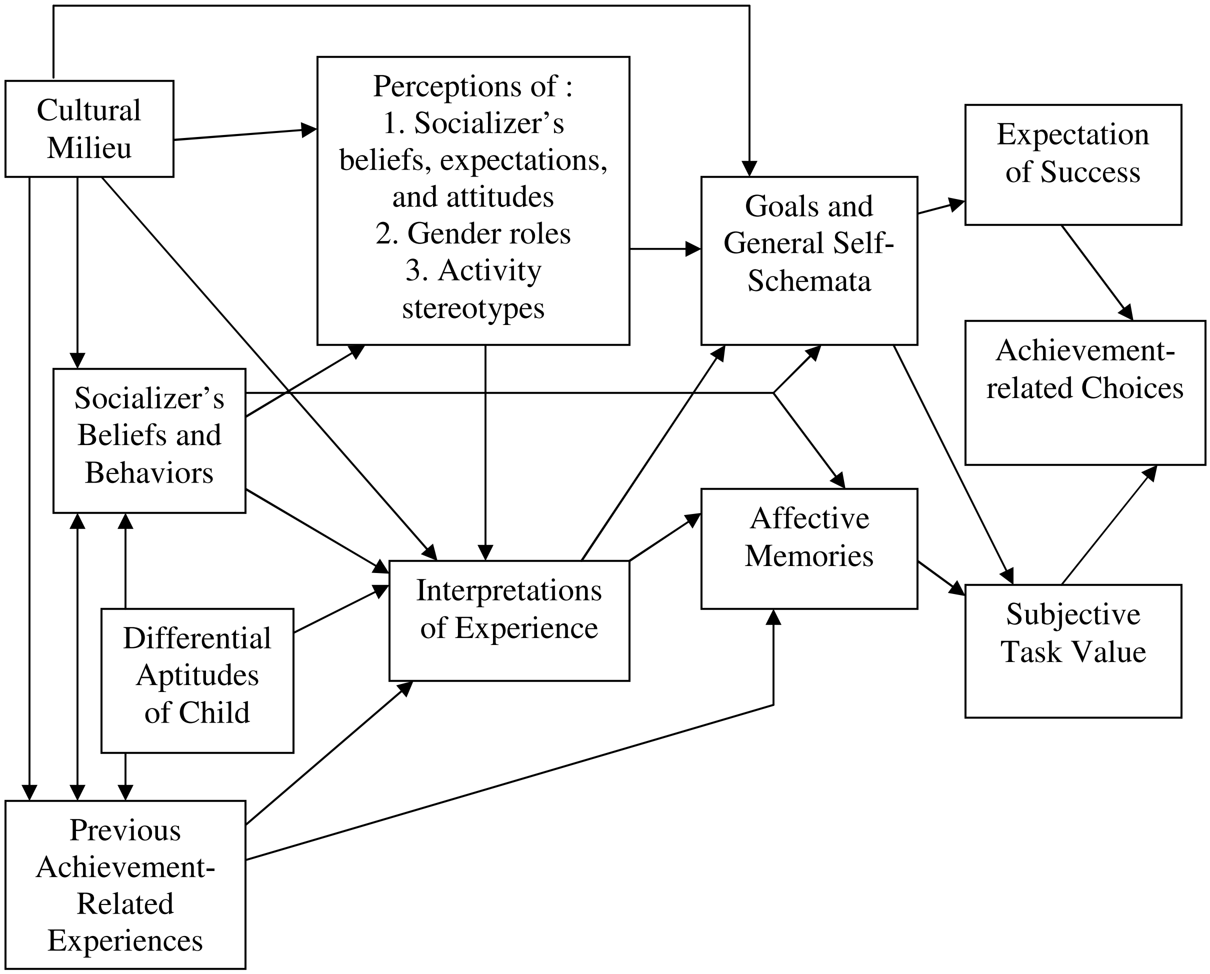

Figure 2. Eccles' (1987) model of achievement-related choices.

The Function of Experiences, Interests, and Abilities

One's experiences in childhood and adolescence are intertwined with the development of abilities and interests (Ferry, Fouad, & Smith, 2000). Naturally, experience with certain activities facilitates the sharpening of activity-specific abilities and interests. One particularly salient example involves the tendency of parents and teachers to encourage girls to pursue typically "feminine" activities, while subtly, if not overtly, discouraging their participation in more "masculine" activities (Beyer, 1995). Women are encouraged by significant individuals (e.g., parents, teachers, and role models) to continue the pursuit of these activities, thus building skills and interests in these areas (Ferry et al., 2000). As experiences and self-efficacy build, clear pathways emerge that lead individuals to continue seeking out the same types of experiences. By high school and college, one has developed a clearer sense of distinct interests and abilities. This is a natural process, yet some skills are underutilized and under-encouraged throughout this developmental phase of life. Thus, potential opportunities for learning are not experienced, and potential opportunities for efficacy and interest development remain unexplored. As experiences in the fields of math and science are not encouraged for many women due to sex role expectations, their innate abilities and possible interests in these areas remained untapped.

Williams and Subich (2006) found gender differences in the learning experiences of men and women, which predicted differences in field-specific self-efficacy and outcome expectations. Specifically, male respondents reported more learning experiences within the Investigative and Realistic interest domains as well as higher self-efficacy beliefs for careers classified as Investigative and Realistic (e.g., science and math). Women reported a greater number of learning experiences within the Social interest domain as well as higher self-efficacy beliefs for careers classified as Social (e.g., teaching and counseling). Self-efficacy scores typically correlated significantly with outcome expectations, which were conceptualized in this study as beliefs that engaging in a certain occupation would result in desired life outcomes. These results suggested the importance of learning experiences, especially performance accomplishments, in the development of self-efficacy beliefs and outcome expectations.

Social Cognitive Career Theory (Lent et al., 1994) cites learning experiences, self-efficacy beliefs, and outcome expectations as major contributors to interest development. Ferry et al. (2000) tested this portion of the model delineated by SCCT to explain the development of math and science career interests. They hypothesized that family context, in the form of parental involvement, parenting style, socioeconomic status, parental math/science proficiency, and type of relationships, influenced one's learning experiences, which, in turn, impacted self-efficacy and outcome expectations. These two constructs shaped one's interests, and had both a direct and mediated effect on one's goals. This research highlighted the unique contribution of family context when considering women's development of STEM-related interests. However, other factors, such as innate ability, must also be taken into account when examining career choice processes.

With regard to natural abilities, women experience relative deficits in spatial skills when compared to men, which may prompt them to seek fields that do not rely on certain mental processes and to avoid careers that do (Brownlow, McPheron, & Acks, 2003). Mental rotation abilities, which involve the cognitive manipulation of three-dimensional objects, tend to be slightly stronger in men, as men are able to rotate multi-dimensional objects more accurately than women. Brownlow et al. (2003) partially attributed this underperformance to women's doubts about their ability to perform mental rotation, which may have been reinforced by gender-role stereotypes. Participants in this study who had taken many chemistry courses performed equally well on tasks involving mental rotation, regardless of gender. Although one must consider the role of self-selection (e.g., women with high levels of ability might have been more likely to take more chemistry courses than women with lower levels of ability), this data suggested that women with experience in this domain did not exhibit less ability than men possessing a similar degree of experience.

Although large differences in cognitive abilities do not exist between the majority of men and women, exceptionally gifted women (top 1%) have been found, at age 13, to possess significantly weaker mathematical reasoning abilities than exceptionally gifted men (Benbow, Lubinski, Shea, & Eftekhari-Sanjani, 2000). In this study, both sexes went on to become exceptional achievers, although they eventually attained different educational and occupational outcomes. Men with greater mathematical abilities tended to be more career-focused, as opposed to striving toward a more balanced lifestyle (Benbow et al., 2000). These men also tended to select more inorganic disciplines, such as engineering, while women opted for more organically-based careers, such as medicine, the social sciences, and the humanities. These choices reflected a potential disparity between the vocational preferences of intellectually-gifted men and women.

While women and men possess some cognitive differences, these differences are not large enough to hinder women's ability to succeed in STEM careers (Brownlow, Smith, & Ellis, 2002). In fact, some cognitive abilities can be improved with training and with more exposure to the specified task (Coleman & Gotch, 1998). Thus, gender differences in cognitive capabilities are not generally regarded as a significant hindrance to women's pursuit of careers in STEM disciplines.

Field-Specific Self-Efficacy

Many researchers speculate on the influence of self-efficacy in the selection of one's vocational interests. Bandura (1977) asserted that personal efficacy expectations help determine how much effort one is willing to expend on a certain task or subject matter, and how long one is willing to persist in the face of obstacles to one's success. Self-efficacy expectations are shaped by four main sources of information: performance accomplishments (e.g., mastery experiences), verbal persuasion (e.g., support and encouragement), emotional arousal (e.g., anxiety), and vicarious learning (Bandura, 1977). Bandura asserted that existing self-efficacy expectations can be modified in either direction by these four sources. Betz and Schifano (2000) tested the impact of an intervention, which included components emphasizing each of the four sources of efficacy-shaping information, that were meant to increase women's self-efficacy with regard to technical skills. This intervention, given in the form of a 7-hour workshop, was found to have significantly increased women's levels of Realistic self-efficacy expectations.

Although all four components have an impact on the development of one's self-efficacy expectations, Bandura (1986) argued that performance accomplishments, which are based on mastery experiences, provide the most influential type of efficacy-shaping information. Luzzo, Hasper, Albert, Bibby, and Martinelli (1999) examined the effectiveness of an intervention aimed at increasing math/science self-efficacy, increasing interest in math and science, and impacting career choice. Participants were randomly assigned to one of four treatment conditions that manipulated the amount of performance accomplishment and vicarious learning each participant received. Results suggested interventions implementing performance accomplishments only, or a combination of performance accomplishments and vicarious learning, significantly affected math/science course self-efficacy, math/science occupational self-efficacy, and interest in a math/science career.

Self-efficacy seems to be of particular importance to women facing non-traditional careers. As the fields of science, technology, engineering, and math prove to be full of obstacles to women's success, a high level of self-efficacy may be needed to advance in, or even to enter, such fields. Betz and Hackett (2006) cited high levels of self-efficacy as predictors of "approach" vs. "avoidance" behaviors, specifically with regard to math-related behaviors. Possessing high levels of field-specific self-efficacy might prompt women to perform more "approach" behaviors (e.g., taking math classes, declaring a STEM major, or applying to graduate school in chemistry) as opposed to "avoidance" behaviors (e.g., opting out of taking an advanced science class, selecting a major with few math requirements). Therefore, the shaping and strengthening of field-specific, or in this case STEM-specific, self-efficacy is essential for women to feel emboldened enough to challenge existing barriers and obstacles.

Interestingly, girls do not display apprehension regarding science and math until their high school years, during which time they tend to attribute success to effort, as opposed to skill (Fouad & Smith, 1996). This lack of efficacy hinders performance, achievement, and interest in these fields (Betz & Hackett, 2006). A lack of self-efficacy makes many women less likely to persist in the face of difficulty and to avoid similar subject matter, thus hampering opportunities to accumulate positive learning experiences. Without these essential learning experiences, how can individuals develop the self-efficacy needed to pursue and to succeed in a chosen vocational field? Although women possess the abilities to perform well in science, math, and engineering fields, their lack of efficacy hinders the achievement of their full potential.

Barriers to Science-Related Careers

Some researchers propose that sex-role socialization impacts women's decisions to avoid STEM disciplines (Brownlow et al., 2002). For example, parents, teachers, and the media send messages suggesting the fields of math and computer science are masculine, while the humanities, such as literature and education, are typically viewed as feminine. After years of sex-role socialization by parents and teachers, which takes the form of discriminatory academic expectations and encouragement, these messages tend to impact peers' views of "appropriate" career choices for men and women. Brownlow et al. (2002) explored this phenomenon. They found that women who pursued a science-related field, such as chemistry, tended to be viewed negatively by peers, as women attributed to them questionable career fulfillment and men reported they would not prefer to date a woman pursuing this type of career. Additionally, the typical feminine sex-role stereotype incorporates social facility and connectedness to others. In general, society perceives scientists, mathematicians, and engineers as lacking these talents; women may not wish to incur this type of characterization from their peers (Brownlow et al., 2002).

Women's perceptions of sex role conflict may also influence their considerations of an STEM career. Sex role conflict was defined by Chusmir and Koberg (1991) as "the inconsistency between one's internal values and the external demands imposed by society due largely to one's biological sex." They proposed that one's level of sex role conflict was not significantly impacted by placement in a field dominated by the opposite sex. However, they hypothesized that those pursuing careers in sex-inappropriate jobs may have already rejected stereotyped gender roles and expectations, thus experiencing less conflict between the role expected of them and their own perceptions of it. In addition, they recognized the possibility that, over time, people may "acquire" certain sex role behaviors when placed in non-traditional employment positions, also limiting the impact of sex role conflict. Although these findings suggested a minimal effect of sex role conflict on women in non-traditional careers, other studies suggest otherwise.

For some women, investment in a traditionally “male” career means putting aside certain priorities, such as romantic relationships and family, which frequently results in their perception of role conflict. Women may be forced to evaluate the strength of their desire for a career or for a fuller family life and to choose between these two seemingly mutually-exclusive roles. Meinster and Rose (2001) examined high school women’s level of investment in work roles versus family roles. They reported that women with higher career aspirations, and thus those who might tend to pursue non-traditional fields, expressed greater investment in work roles as opposed to family roles. Women with lower educational aspirations tended to express similar levels of investment in both work and family roles. This research suggested that women pursuing more non-traditional fields, such as math and engineering, did not place as much emphasis on family. This finding did not suggest that their value for family life was nonexistent, simply that it may have been a lower priority for these types of women. In fact, most women wish to pursue a career that affords them the ability to develop a family life (Lips, 1992). STEM careers are generally not perceived as allowing for this desire. Thus, women may hesitate becoming invested in a career that may hinder their ability to develop and possess a fulfilling family life, regardless of the prestige or financial incentives connected to their position.

Some women may struggle to balance the demands of a nontraditional career with the concurrent demands of a household, for which women typically shoulder the majority of responsibility. Perrone, Webb, and Blalock (2005) investigated differences in life role participation between women and men. When asked to report their ideal proportions of time spent in each of seven roles (time with spouse, parenting, housework, work, leisure, community, and study), women and men did not differ significantly on any of the seven domains. However, when asked to report the proportion of time they typically participated in these various roles, both sexes identified women as spending a significantly larger proportion of time performing household and childcare tasks than men. Men reported greater participation in career and leisure tasks than women. Although both sexes reported possessing similar ideal proportions of time spent in each role, in reality, women spent a significantly greater proportion of time on household tasks. When these data were analyzed by controlling for salary, the findings remained the same. Thus, women who made more money than their husbands continued to spend significantly more of their time on household responsibilities than men (Perrone et al., 2005). Although the world of work is steadily evolving, women continue to take on a disproportionately larger amount of household responsibility than men, regardless of their ideal role preferences. These obligations may result in women's reluctance to pursue a challenging career while simultaneously acting as the primary provider of household care.

Women also may be hesitant to pursue non-traditional fields because they tend to provide a more hostile and less accommodating work environment. The American Chemical Society reported that female chemists experience more discrimination than in other fields and make less money than their male counterparts (American Chemical Society, 2001). A British study reported that over 55% of differences in career success between men and women were due to sex discrimination (Melamed, 1995). Occupational segregation may exist due to the perception that women, who tend to value home life more than work to a greater degree than men, are less suitable for jobs requiring high levels of commitment to an organization

(Browne, 1997). This may result in discriminatory hiring practices for high-level, extremely competitive positions. However, researchers (Browne, 1997; Fagenson, 1993) asserted that this difference did not exist; women and men shared the same levels of career involvement, work values, and occupational preferences.

Some women may believe they cannot succeed in a scientific field without putting in more effort and working harder than men (Jussim & Eccles, 1992). They may perceive, as in high school, that their successes in traditionally "male" fields are due not to natural ability, but to the amount of effort they are willing to invest. Therefore, regardless of their abilities, they will need to work harder to keep up with their male counterparts. This mindset makes working toward a career in these fields less attractive than a traditional, stereotypically "feminine" alternative. Women not only risk having to work harder in traditionally "male" professions, but also chance suffering from greater amounts of stress. Gerdes (1995) reported differences in susceptibility to physical and psychological outcomes due to gender. According to this research, women pursuing careers in non-traditional fields were more susceptible than men with similar career goals to these negative outcomes, such as chronic job tension. Women preparing for non-traditional professions also experienced stronger predictors of these symptoms than other women preparing for traditional professions (Gerdes, 1995). It appears from these findings that women pursuing non-traditional fields experience more negative physical symptoms than both men and traditionally-oriented women.

Nauta, Epperson, and Kahn (1998) examined a segment of Lent, Brown, and Hackett's (1994) Social Cognitive Career Theory, with a focus on the functions of sex role conflict and positivity of role modeling influence within that model. To predict women's higher-level career aspirations, these researchers proposed that ability and positivity of role modeling influences helped shape one's degree of self-efficacy. Positivity of role model influence also worked to form one's perception of role conflict. Both self-efficacy and the perception of role conflict impacted higher-level career aspirations, which were defined as aspirations to an advanced position within a particular field. This model uniquely identified one's perception of role conflict and the influence of positive role modeling relationships as contributors to women's STEM-related career aspirations.

The Impact of Role Modeling

Supportive role modeling has been found to combat many potentially powerful deterrents to the pursuit of careers in STEM disciplines, thus facilitating women's professional development and success in their respective fields (Betz & Fitzgerald, 1987; Hayden & Holloway, 1985; Stake & Noonan, 1985). In fact, mere exposure to women pursuing careers in the sciences was found to positively impact students' attitudes toward women in science (Smith & Erb, 1986). This exposure incorporated discussions of women's contributions to science, meetings with women working in science-related careers, and readings about young women pursuing these careers. These findings suggested that increasing students', especially young girls', familiarity with women pursuing non-traditional careers led to an increased likelihood of acceptance of an STEM career for themselves and for their peers.

Women's experiences of role modeling tend to impact their career choices and aspirations, especially in male-dominated fields. Mentors and role models are essential for females pursuing careers in law, as these relationships often result in higher earnings, more promotional opportunities, and greater social integration (Wallace, 2001). Role modeling may be especially important for women in STEM fields because they tend to face greater challenges to advancement than their male counterparts (Ragins & Scandura, 1994). Extra support may be necessary to overcome these disadvantages. In addition, role modeling benefits women by helping shape realistic and appropriate expectations of career aspirations (McManus & Russell, 1997). For example, a female engineer may observe certain qualities about her supervisor that allow her to more accurately identify advantageous personal characteristics facilitating promotion or advancement in the field. As one can observe, role models often provide advantageous opportunities for women's professional development and overall success in STEM careers.

Unfortunately, negative developmental relationships can have a detrimental impact on women's pursuit of non-traditional careers. Scott and Mallinckrodt (2005) surveyed a sample of women 1 to 2 years after graduating from high school to assess their reported college major, science self-efficacy, and quality of emotional bonds with their parents. Their findings revealed that having a father who acted controlling or withdrew affection was significantly negatively related to self-efficacy for science educational requirements. Degree of fathers' warmth and emotional expressiveness were not significantly positively correlated with the development of this type of self-efficacy. Having a controlling or withdrawn father tended to result in lower self-efficacy scores, while having a warm father had no effect. Relational bonds with mothers were not significantly related to level of self-efficacy for science educational requirements. In sum, paternal relationships had a significant impact on women's science-related self-efficacy, especially if the relationships were negative. These findings stress the importance of understanding the ramifications of complex developmental relationships within women's, and men's, vocational decision-making processes.

Although the research literature documents the primarily beneficial impact role models have on women, substantial ambiguity surrounds what actually constitutes a role model. Traditionally, role models have been perceived as people in influential positions who provide a model for others to imitate (Gibson, 2004). However, this somewhat vague definition of role modeling does not fully describe the complex, multi-faceted phenomenon described in the research literature; thus, a more thorough evaluation of the construct is warranted. Gibson (2004) critically examined the construct of the "role model" and defined it as "a cognitive construction based on the attributes of people in social roles an individual perceives to be similar to him or herself to some extent and desires to increase perceived similarity by emulating these attributes" (p. 136). Gibson's definition relied heavily on the implication that an individual perceives a figure as a role model, based on similarity to oneself and to one's ideal self, with or without the knowledge of the selected figure. Pleiss and Feldhusen (1995) defined role models merely as "adults who are worthy of imitation in some area of life" (p. 163). This definition, similar to Gibson's (2004) definition, did not imply a relationship between the protégé and role model, simply the protégé's recognition of the role model's worthiness as an object of imitation. Based on these definitions of role modeling, one may select as a role model a famous or fictional character, such as Barbara Streisand or Mighty Mouse, as well as someone involved in a relationship with the individual, such as a parent or mentor. One may assume that a difference exists between these two types of role models; an interactive relationship between two individuals, as opposed to no contact at all, may possess a greater chance of influencing the individual.

Gibson (2004) helped to clarify this distinction when he differentiated role modeling from mentoring. For Gibson, role modeling often incorporates behavioral modeling, which involves the vicarious observation of specific tasks and skills, social comparison to another person possessing similar or desired traits, the development of role expectations, and the definition of one's self-concept. None of these activities requires active interaction between the individual and the role model. In contrast, Gibson viewed mentoring as incorporating an interactive relationship between mentor and protégé. Although role modeling and mentoring may sometimes possess similar characteristics, mentoring entails the mentor taking an active interest in the professional development of the protégé, while role modeling does not necessarily do so. In other words, a role model may not necessarily be involved in an ongoing relationship or interaction with the individual, while mentors generally are.

Researchers examining formal mentoring programs within the corporate world have found evidence suggesting the importance of specific relational components to the development of a satisfactory mentoring relationship. For example, Wanberg, Welsh, and Kammeyer-Mueller (2007) identified level of protégée self-disclosure as a significant correlate to satisfaction with mentor. According to this study, increased protégée self-disclosure typically led to greater satisfaction within the mentoring dyad for the protégée. Lankau, Riordan, and Thomas (2005) examined the importance of mentor-protégé similarity to mentoring relationships within a formal program. Their results suggested demographic similarity (e.g., age, race, gender) did not impact the mentoring relationship, but deeper characteristics, such as work values and personality, did. These findings support the existence of a strong relational component within mentoring dyads.

Edlind and Haensley (1985) cited the following seven specific functions of a mentor for a protégé: advancing their career and interests, increasing general knowledge and skills, developing talents, enhancing self-confidence, developing a personal ethic and standards, establishing a friendship, and enhancing creativity. Other qualities identified by Pleiss and Feldhusen (1995) included providing a secure environment, assisting in the development of goals, promoting the development of field-specific interpersonal skills, facilitating professional socialization, and transmitting values. These characteristics provide a fairly thorough conceptualization of the qualities of a mentor, yet do not accurately describe the functions of a role model. A distinction must be made between these two concepts. The definition of a mentor tends to highlight the reciprocal relationship between two individuals in a mentoring dyad, while the definition of a role model tends to be less interpersonally-focused.

A synthesis of these conceptualizations suggests that role models must necessarily meet Gibson's (2004) criteria of being "individuals selected for imitation based on their capability to model relevant skills, to motivate and inspire, and to aid in the development of one's professional self-concept." Selected role models may then differ in their degree of activity or involvement in the individual's life. This continuum of role model activity/involvement would be anchored by "passive role modeling" on the inactive/uninvolved end and by "mentoring" on the active/involved end. An attempt will be made to investigate the entire role modeling continuum in this study.

Purposes of the Study

The purposes of this study were twofold. It first attempted to explore the complex interplay among women's experience of role modeling, interests, perceptions of sex role conflict, and STEM self-efficacy and the degree to which these variables predicted women's levels of career aspirations with regard to STEM fields. Secondly, this study aimed not only to identify the utility of role modeling to women pursuing STEM careers, but to assess the impact of quality, as opposed to quantity, of role modeling experiences on the career aspirations of women in these areas.

Specific characteristics of role modeling, as well as the extent of its impact on career choices, lack much empirical validation. Research concretely defining effective role modeling remains limited. Although many use the term “role model,” it is a vaguely-defined construct and can be described by a variety of parameters (Gibson, 2004). Thus, research is hindered by inconsistent measurement techniques and by an unclear conceptualization of the construct of role modeling. By delineating some characteristics of effective role models, this study may help to differentiate this unique phenomenon from other types of developmental relationships with which it has typically been combined, such as mentoring and behavioral modeling.

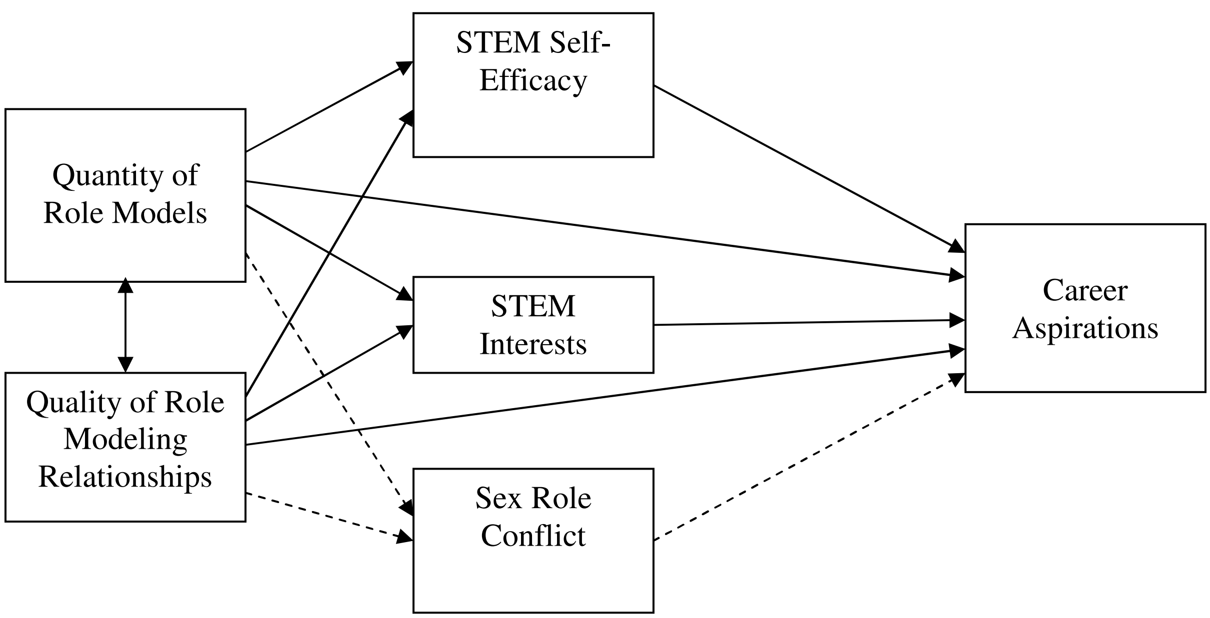

Figure 3. Hypothesized model of connections among assessed variables.
(⟶ = positive relationship, - - - ► = inverse relationship)

I utilized Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994) and Eccles' (1987) model for women's achievement-related choices as a basis for my hypothesized model. Neither SCCT (see Figure 1) nor Eccles' model of achievement-related choices (see Figure 2) cite role modeling as a distinct contributor to women's vocational interests or choices. However, they both emphasize the importance of one's environment and socialization experiences, which lends support to the significance of an individual's personal relationships with regard to career choice. Thus, this study aimed to identify the importance of these personal relationships, in the form of role modeling, with regard to women's career-related interests and choices.

According to my hypothesized model, the quantity of role models in one's life and the quality of mentoring they provided were predicted to positively influence one's STEM self-efficacy, interests, and career aspirations, while decreasing one's sex role conflict. Although the quantity of role models and quality of mentoring were predicted to directly influence career aspirations, it was also hypothesized that these relationships would be mediated to some degree by STEM self-efficacy, interests, and sex role conflict (see Figure 3).

CHAPTER 2: METHOD

Participants

The sample for this study consisted of 232 first and second-year women enrolled in a large, Midwestern university pursuing majors in the following fields: animal ecology, agriculture (undeclared), agricultural biochemistry, agronomy, animal science, applied physics, agricultural systems technology, biochemistry, biology, biophysics, botany, chemistry, computer science, dietetics, dairy science, earth science, economics, environmental science, entomology, forestry, food science, genetics, general preveterinary medicine, geology, health and human performance, horticulture, industrial technology, mathematics, microbiology, meteorology, nutritional science, physics, pre-computer science, pre-professional health programs, preparation for human medicine, pre-biological/pre-medical illustration, physics, plant health and protection, statistics, zoology, or any of the engineering fields. All 2,745 first and second-year women majoring in these areas received an e-mailed invitation to participate in an online questionnaire during the summer and fall semesters of 2006. Although survey and ability data were obtained for 232 participants, only 163 of the 232 had UNIACT-R interest scores. Consequently, the reduced sample of 163 was used for analyses involving interest measures. The full sample of 232 was used for all other analyses.

This sample consisted primarily of women who identified as Caucasian (88.4%), while 5.2% identified as Asian, 3.4% identified as Latina, 2.2% identified as African American, and 0.9% chose not to respond. A small segment of this sample listed a secondary ethnicity with 1.7% identifying as Caucasian and 0.4% identifying as International.

Materials

Experience and ability

Although not in the formally hypothesized model, experience and ability were assessed in this study as potentially relevant predictors of women's STEM career aspirations. To measure the quantity of STEM experiences, participants listed high school coursework taken in mathematics. The total number of high school math courses taken was calculated for each participant to determine the quantity of their individual experiences.

Scores on the Mathematics subtest of the ACT (ACT, Inc., 1997) were used to quantify abilities. These scores range from 1-36. The ACT is positively associated with grades in high school and college math and science courses.

Quantity of STEM role models

To determine the quantity of one's role modeling relationships with regard to science, technology, engineering, or math, participants were given a definition of the term "role model" ("a person you have admired because they have been able to model skills in science, technology, engineering, or math and to do one or both of the following: (1) to motivate you to pursue a scientific, technological, engineering, or mathematical field, (2) to help you develop your professional identity in a scientific, technological, engineering, or mathematical field") and asked to list up to 10 people in their lives they felt fit that description (see Appendix A). For each role model listed, participants provided the name, gender, and relationship of the role model to the participant. Participants were requested to limit their list to role models they experienced prior to attending college. A total score was calculated to reflect the cumulative number of role models each participant had encountered.

Quality of STEM role models

Participants were asked to select one person they considered to be the most influential ("possessing the capability of having an effect on the development of someone"). The quality of this role model was assessed with a revised version of the Advisory Working Alliance Inventory (AWAI; Schlosser & Gelso, 2001). The original 30-item measure assessed the working alliance between advisors and advisees, focusing specifically on Rapport, Identification, and Task Focus as main components of the advisor-advisee working alliance. This inventory used a 5-point Likert type scale (1 = strongly disagree; 5 = strongly agree). High scores reflected a working alliance that was closer and more like a mentor-protégé relationship than an advisor-advisee relationship. Composite scores on the original AWAI were internally consistent, possessing an alpha coefficient of .95 and a test-retest reliability coefficient of .92 (Schlosser & Gelso, 2001).

Because no strong measures of the quality or influence of role models were identified at the time of this study, the AWAI (Schlosser & Gelso, 2001) was selected as measuring a close approximation of the construct of mentoring/active role modeling. To tailor this measure to the purposes of this study, items that dealt primarily with school or advising relationships were eliminated, as they could not be applied conceptually to assess role modeling. Selection of the remaining items was guided by factor loadings, resulting in a 14-item questionnaire (see Appendix B). One example of an item on this scale was, "I learned from my role model by watching him/her." The directions and wording of the items on this instrument were modified slightly to assess the quality of the participants' single, most influential role modeling relationship, rather than an advisory relationship. This revised measure yielded a coefficient alpha of .75 in the present study. A total score was calculated for this measure by averaging participants' responses to the items.

Participants also answered two exploratory items for every role model they listed. These items were created to gauge participants' beliefs that a career in a STEM field had become more desirable and/or more attainable due to interaction with that role model (see Appendix A). These questions used a 4-point Likert type scale (1 = not at all; 4 = a great amount). Average scores for these two questions significantly predicted career aspirations when tested in the model ($\beta = .207$, $p = .006$). However, when compared with the AWAI ($\beta = .266$, $p = .001$), scores on these two items did not provide the most optimal representation of quality of role modeling relationship. Items on the AWAI appeared to provide a more comprehensive and reliable assessment of role model quality. Therefore, average scores on the AWAI were selected as the best representation of this construct.

Interests

The UNIACT-R (UNIACT-R; Swaney, 1995) was utilized to assess participants' interests. This unisex interest inventory is comprised of 90 items representative of six scales corresponding to Holland's themes: Technical (Realistic), Science (Investigative), Arts (Artistic), Social Service (Social), Business Contact (Enterprising), and Business Operations (Conventional). Items on this measure emphasize work-relevant activities that might be familiar to the respondent, as opposed to specific job duties or titles. Items possess a three-choice response format (like, indifferent, dislike). The UNIACT-R produced an internal consistency coefficient of .83 - .91 across subscales for adult women and .77 - .90 for adult men as well as a test-retest reliability coefficient of .69 - .82 across subscales for adult women and .68 - .78 for adult men (Prediger & Swaney, 1995). The Technical scale possessed a coefficient alpha of .83 for adult women and .88 for adult men, while the Science scale possessed a coefficient alpha of .91 for adult women and .90 for adult men (Prediger & Swaney, 1995). To obtain a score most representative of the degree of participants' interest in STEM fields, scores on the Technical and Science scales were averaged for each participant. Most recent scores were used for participants who had taken the UNIACT-R more than once. Only 70% of the sample who consented to the release of their ACT information possessed accessible UNIACT-R scores (n = 163).

STEM self-efficacy

A version of Lent, Brown, and Larkin's (1986) Self-efficacy for Academic Milestones Scale was used to assess college students' science, technology, engineering, and math self-efficacy. The original 11-item measure assessed self-efficacy only for engineering majors. The coefficient alpha for the original scale was .89 (Lent et al., 1986). To incorporate majors in science, technology, and mathematics, as well as to reduce ceiling effects, Nauta et al. (1998) created a revised version of this tool. The revised measure included 14 items, on which students rated their confidence in their ability to succeed in science and engineering majors (see Appendix C). A 10-point Likert-type scale (1 = completely unsure; 10 = completely sure) is used on this instrument. For example, one item on this scale asked participants to rate their certainty of being able to, "Excel in science, math, or engineering over the next semester." A total score was calculated for this measure by averaging participants' responses to the items. Higher scores indicated higher levels of STEM self-efficacy, with a maximum score of 10. The revised version of this measure possessed a Kuder-Richardson 20 reliability of .90 and was found to be positively related to STEM leadership aspirations (Nauta et al., 1998). In the present study, this measure yielded a coefficient alpha of .95.

Sex role conflict

Although multiple measures were evaluated to assess the construct of sex role conflict, a set of seven items developed by Lips (1992) appeared to most optimally reflect women's gender-related attitudes toward pursuing a career in a STEM field. This questionnaire, labeled for the purposes of this study as the Lips Role Conflict Scale, examined women's beliefs in the compatibility of scientific career and familial responsibilities (see Appendix D). Each item was rated on a 5-point Likert-type scale (1 = strongly disagree; 5 = strongly agree). One sample item stated, "If a woman chemist or physicist takes time away from her career to have children, she will never catch up again." A total score was calculated for this measure by averaging students' responses to the items. Higher scores suggested positive attitudes regarding women's combination of scientific careers and family. Past research conducted by Lips (1992) reported a reliability coefficient of .75 for these items. In the present study, this set of items yielded a coefficient alpha of .81. Lips (1992) noted a positive correlation between scores on these items and women's choice of science-related vocational goals, thus supporting this measure's validity.

Career aspirations

The Career Aspiration Scale (CAS; O'Brien, 1995) was utilized to quantify levels of career aspirations (see Appendix E). This instrument is comprised of 11 items and used to assess subjects' career plans and goals within their chosen occupation. One example of an item on this scale was "I plan on developing as an expert in my career field." This instrument used a 5-pt Likert-type scale for each item (1 = not at all true of me; 5 = very true of me). In past research, it possessed an internal consistency of .77 (O'Brien & Fassinger, 1993). This measure's validity was supported by positive correlations with measures of career salience, academic ability, number of semesters of math and science courses, and career self-efficacy (O'Brien, 1996). In the present study, the CAS possessed a coefficient alpha of .76.

Procedure

Following IRB approval, the university registrar's office was contacted to acquire a list of all first and second-year female college students majoring in science, technology, engineering, and math fields. All women identified on the list received an emailed letter of solicitation that invited them to participate in the study by visiting the provided web site and completing an online survey. The website included an informed consent statement, a demographic questionnaire (see Appendix F), and an online survey comprised of the selected measures described above. After 10 days, students who had not completed the online questionnaires by that time received an e-mail reminder. Another reminder was e-mailed to those who had not participated after an additional 10 days. Data collection occurred during the summer and fall semesters of 2006.

Analyses

After the data were collected, multiple regression analyses were used to explore the relations among the variables assessed in this study. Multiple regression analysis typically provides a very robust estimate of the path coefficients within a tested model. Although structural equation modeling was originally intended to be utilized in addition to multiple regression, an inadequate sample size prevented the usage of this type of analysis. Therefore, only multiple regression analyses were used to estimate the paths of the tested model in this study.

CHAPTER 3: RESULTS

Preliminary Analyses

Means, standard deviations, sample sizes, and intercorrelations for the measures used in this study are presented in Table 1. Respondents' raw scores on the UNIACT-R were standardized with a mean of 50 and a standard deviation of 10 (Prediger & Swaney, 1995). Not surprisingly, participants in this study obtained scores on the Technical and Science scales that were slightly higher than average (M = 56.32) and somewhat more homogenous (SD = 7.88) when compared to ACT's national sample.

Scatterplots of all bivariate relations were visually examined for potential outliers that might exert an undue influence on the bivariate association. Although a small number of potential outliers were identified, the responses of these participants appeared to be meaningful and appropriate. There was no indication of random responding or not following survey instructions. Furthermore, there was no indication that the responses of these participants suppressed or changed the observed bivariate relations between variables. Consequently, all participants were retained for analyses.

Data was collected for two potential exogenous/control variables: mathematical ability and high school math courses completed. Based on relevant research literature, both were hypothesized to be potential predictors of career aspirations. Preliminary analyses indicated that neither of these variables significantly correlated with career aspirations; therefore, both variables were excluded from subsequent analyses.

Table 1

Means, Standard Deviations, Sample Sizes, and Intercorrelations Between Measures

Measure	1	2	3	4	5	6
1. Total RMs	-					
2. Quality of RM	.14	-				
3. Interests – TS	.10	-.04	-			
4. Self-efficacy	.05	.05	<.01	-		
5. Role Conflict	.04	.09	-.12	.11	-	
6. Career Aspirations	.11	.27*	-.04	.25*	.10	-
M	2.00	4.18	56.32	7.94	4.02	3.84
SD	2.16	.46	7.88	1.66	.66	.57
N	231	162	163	227	219	212

Note. Total RMs = total number of role models reported; Quality of RM = score on Advisory Working Alliance Inventory; Interests – TS = average of Technical and Science UNIACT-R scale scores; Self-efficacy = score on Self-efficacy for Academic Milestones Scale; Role Conflict = score on Lips Role Conflict Scale; Career Aspirations = score on Career Aspiration Scale.

* $p < .05$

Regression Analyses Predicting Career Aspirations

To evaluate whether the assessed variables predicted career aspirations, a series of linear regression analyses were conducted using SPSS (see Figure 4). Due to the existence of potential mediators within the hypothesized model, guidelines set forth by Baron and Kenny

(1986) were observed to most effectively evaluate the relations among the assessed variables. According to Baron and Kenny (1986), a model must meet a specific set of criteria in order to identify variables as mediators within a statistical model: 1) a relation must exist between the predictor and the mediating variable, such that variations in the predictor variable account for variations in the mediator variable, 2) a similar relation must exist between the mediating

Table 2

Summary of Linear Regression Analyses for Role Model Variables Predicting Potential Mediators

Predictor	*B*	*SE B*	*95% CI*	*β*	*p* <
Total RMs					
Interests – TS	.35	.27	-.17 to .88	.10	.19
Self-efficacy	.04	.05	-.06 to .14	.05	.45
Role Conflict	.01	.02	-.02 to .05	.04	.52
Quality of RM					
Interests – TS	-.67	1.69	-4.01 to 2.68	-.04	.69
Self-efficacy	.17	.27	-.37 to .71	.05	.54
Role Conflict	.14	.12	-.09 to .37	.09	.24

Note. Total RMs = total number of role models reported; Quality of RM = score on Advisory Working Alliance Inventory; Interests – TS = average of Technical and Science UNIACT-R scale scores; Self-efficacy = score on Self-efficacy for Academic Milestones Scale; Role Conflict = score on Lips Role Conflict Scale. No relationships were significant ($p < .05$).

variable and the criterion variable, and 3) when the relations described in criteria 1 and 2 are controlled, the previously significant relation between the predictor and the criterion variable no longer remains significant. If these criteria are violated, the assessed variables cannot be labeled as mediators within the tested model.

In accordance with these guidelines, the relations between the predictor variables and the potential mediating variables were assessed. The two role model variables used in this study did not significantly predict the potential mediating variables (see Table 2), thus violating the first criterion posited by Baron and Kenny (1986). Therefore, STEM self-efficacy, STEM-related interests, and sex role conflict could not be regarded as mediators within this study's tested model.

As shown in Table 3, quality of role modeling relationships and STEM self-efficacy both significantly predicted career aspirations, ($\beta = .27$), $F(1, 160)$, $p < .01$ and ($\beta = .26$), $F(3, 158)$, $p < .01$, respectively. Additionally, the standardized beta for quantity of role models, ($\beta = .11$), $F(1, 209)$, $p = .10$, suggested a nonsignificant trend toward predicting career aspirations. Although STEM self-efficacy significantly predicted career aspirations in this model, it was not found to mediate the relation between quality of role modeling relationships and career aspirations, as suggested in the hypothesized model. Additionally, STEM-related interests and sex role conflict did not significantly predict career aspirations (see Table 3), as originally hypothesized. The final model accounted for 19.1% of the variance in CAS scores, $F(5, 112) = 5.31$, $p < .01$.

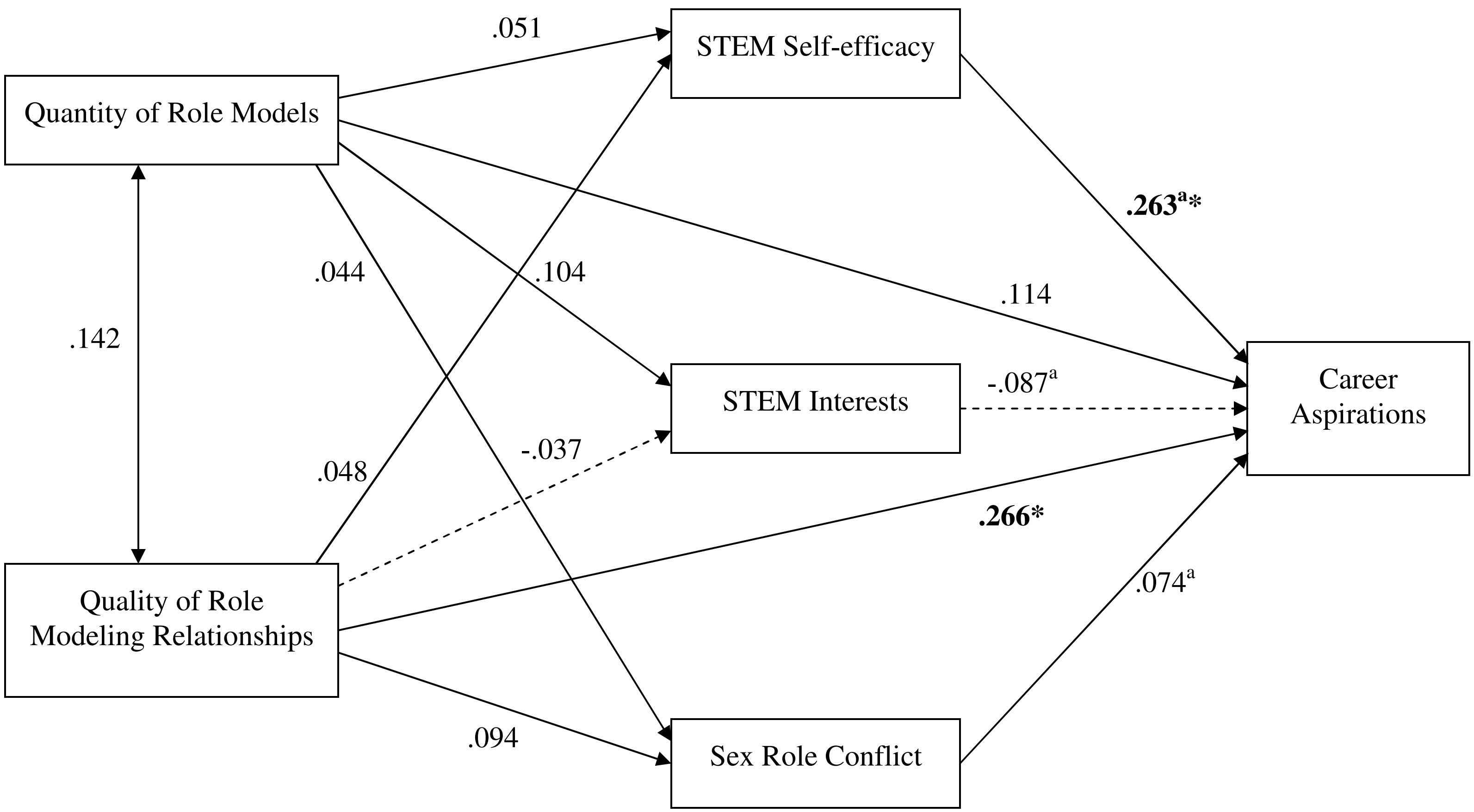

Figure 4. Observed model of variables predicting career aspirations.
[a]Paths from potential mediators to career aspirations were calculated by controlling for role model variables.
* $p < .05$
(⟶ = positive relation, - - - -▸ = inverse relation)

Table 3

Summary of Linear Regression Analyses for Variables Predicting Career Aspirations

Predictor	*B*	*SE B*	*95% CI*	*β*	*p* <
Total RMs	.03	.02	-.01 to .07	.11	.10
Quality of RM	.31	.09	.14 to .49	.27	.01*
Interests – TS[a]	-.01	.01	-.02 to .01	-.09	.33
Self-efficacy[a]	.09	.03	.04 to .14	.26	.01
Role Conflict[a]	.06	.06	-.06 to .18	.07	.33

Note. Total RMs = total number of role models reported; Quality of RM = score on Advisory Working Alliance Inventory; Interests – TS = average of Technical and Science UNIACT-R scale scores; Self-efficacy = score on Self-efficacy for Academic Milestones Scale; Role Conflict = score on Lips Role Conflict Scale.

[a]Paths from potential mediators to career aspirations were calculated by controlling for role model variables.

* $p < .05$

CHAPTER 4: DISCUSSION

On the basis of highly researched and theoretically sound career development models (i.e., Social Cognitive Career Theory and Eccles model of achievement-related choices), a model was generated to predict levels of career aspirations held by first and second-year women majoring in science, technology, engineering, and mathematics at Iowa State University. The model did not fit the data well in that only two of the five paths to career aspirations were statistically significant. The two significant paths emerged from STEM self-efficacy and from quality of role models. The paths from quantity of role models, technical/scientific interests, and sex role conflict failed to predict career aspirations.

The impact of self-efficacy beliefs on outcome expectations and goals has been widely supported in the research literature (Bandura, 1977; Luzzo et al., 1999) and was one of the strongest predictors of career aspirations out of the variables assessed in this study. Despite its placement as a mediator within the hypothesized model, it was not found to mediate the paths between the two role model variables and career aspirations. In fact, none of the potential mediators tested in this study mediated the paths within the model. This was an additional way in which the results of the current study are inconsistent with the dominant theoretical model (SCCT) in the literature.

Quality of role modeling relationships, evaluated in this study with a revised version of the Advisory Working Alliance Inventory (AWAI; Schlosser & Gelso, 2001), also significantly predicted levels of career aspirations for women majoring in STEM fields. This finding is striking, given that few studies have evaluated the characteristics of role modeling within a vocational context; specifically, the difference between quantity and quality of role modeling experiences has received little attention in the literature. Although vocational research on SCCT has identified role modeling, and its theoretical sibling mentoring, as a contextual influence pertinent to choice behavior, little is known regarding the impact of these types of influences on one's vocational development. Role modeling falls under the wide categorical umbrella of constructs proximal to choice behavior, such as sex role conflict and socioeconomic status. These contextual influences remain secondary to the "primary" constructs of self-efficacy, outcome expectations, interests, and goals when it comes to vocational research design. As such, few domain-specific measures have been developed to assess this portion of the theoretical model (Lent & Brown, 2006). However, this is a critical dimension because it has direct implications for interventions designed to increase the representation and persistence of women in STEM disciplines.

The predictive influence of role modeling relationship quality on career aspirations appears robust in this study. This construct was assessed with a revised version of a 30-item measure developed to evaluate the type of relationship within a graduate school advisor and advisee dyad. Therefore, many items were immediately removed due to their lack of salience to the types of relationships potentially experienced by undergraduate women, resulting in a 14-item tool. As an experimental measure, expectations were low with regard to its internal consistency and predictive validity. However, it achieved an adequate coefficient alpha and significantly predicted levels of career aspirations. Clearly, more development of this measure is needed to produce a highly reliable and psychometrically robust method of assessing role model relationship quality.

Given the experimental nature of the revised version of the AWAI, another set of items were developed to assess quality of role modeling relationships. These items allowed participants to rate the degree they felt each role model they listed influenced the attainability and desirability of a career in STEM. Averages of these ratings were calculated across all listed role models for each participant. Unlike the revised version of the AWAI, which assessed the relationship between each participant and their single most influential role model, these item ratings reflected the quality of *all* role modeling relationships reported by the participant (e.g., parents, teachers, coaches, grandparents). When placed within the hypothesized model, these ratings also significantly predicted levels of career aspirations. Although not formally utilized within this study because of the AWAI being a somewhat stronger measure, this finding reinforces the significance of the quality of these types of relationships with regard to one's vocational aspirations.

Implications for Practice

Given the disproportionate percentage of women pursuing careers in some STEM fields, especially computer science, engineering, and physics, an understanding of the influences on these women's career-related choices is essential for facilitating their pursuit of these careers. Multiple barriers exist for women considering the pursuit of a nontraditional career, such as limited exposure to field-specific role models and society's continued stigmatization of women in these types of fields. In order to increase the chance of overcoming existing barriers, women must receive adequate support throughout their vocational development. This support may arrive in the form of formal self-efficacy building curricula, mentoring programs, or exposure to women pursuing careers in science, technology, engineering, or math.

The results of this study emphasize the importance of women's development and maintenance of field-specific self-efficacy in order to develop high levels of career aspirations. The role of self-efficacy is widely accepted by researchers as a major component of the successful pursuit of vocational choices. Multiple interventions have been designed within the past decade to increase STEM self efficacy beliefs among girls ranging in age from grade school to college (Luzzo et al., 1999; Betz and Schifano, 2000). These interventions generally have been found to be successful, but a large number of barriers exist that often hinder the progress made within these programs.

This study suggests women who have interacted in a meaningful way with at least one role model possess higher career aspirations than those who have had less meaningful role modeling relationships, or perhaps even none. According to this study's findings, quantity of role models does not matter as much as the quality of the role modeling relationship. This has implications for the development of formalized mentoring programs. Perhaps these programs would benefit from focusing on facilitating one or two supportive, high-quality role modeling relationships as opposed to exposing women to a large number of role models with whom they only shallowly interact.

By conceptualizing some important factors impacting women's career aspirations, we can provide specific services to women that will assist them in fully developing their interests, skills, and values. Not all women will want to pursue careers in a STEM field, and that should not be the goal of vocational services. However, by removing barriers and providing essential supports, these types of programs can assist women in pursuing a career they might normally not have considered.

Limitations of Study

This study has a number of limitations. A major limitation of this study is its relatively small sample size. Despite efforts to elicit participation from all 2,745 first and second year women majoring in STEM fields, only 232 women responded to the surveys and granted access to their UNIACT information. Of this already limited sample, only 70% possessed accessible UNIACT scores. As one can see, the original sample of 232 respondents was eventually greatly reduced for analyses involving vocational interests. This small sample precluded the formal use of structural equation modeling, and it reduced the statistical power of the analyses. Because of this decreased power and the elevated potential for Type II errors, the predicted paths from SCCT that were non-significant should be interpreted with caution. Nonetheless, the emergence of significant paths for STEM self-efficacy and quality of role models, as well as a non-significant trend for quantity of role models, within this context remains meaningful.

A second major limitation of this study centers around the characteristics of the measures selected to assess its constructs. Although every effort was made to utilize the best available measures for each theoretical construct, some of the measures were not ideal and perhaps even problematic. Unfortunately, one of the problematic measures was the one used to assess the primary dependent variable, career aspirations. The Career Aspiration Scale (CAS; O'Brien, 1995) initially was selected to measure levels of STEM-related career aspirations, and is commonly used by researchers for this purpose. However, the CAS did not optimally reflect the intended construct and, therefore, could not be used as a measure of women's aspirations specific to a STEM career. Although it appears to assess one's desire to achieve in the workplace, it does not specify one's desire to achieve within a *STEM* workplace. No items on this measure asked specifically about involvement or achievement in a STEM career; thus, this tool could not be used to form implications regarding women's aspirations strictly within a STEM field. This important distinction may partially explain why Investigative and Realistic interests did not significantly predict levels of career aspiration within the tested model. Enterprising interests correlated most highly with scores on the CAS. This makes sense, given that many items on this tool, such as, "When I am established in my career, I would like to manage other employees," pertained to leadership and business advancement. This is a serious concern, given this construct was the outcome variable within this study's tested model. Therefore, all interpretations of findings should be considered carefully within this context. As this sample is followed up over time, a different measure will be used to reflect aspirations pertaining specifically to STEM-related careers, and the primary criterion variable will be measured as a behavioral outcome (e.g., persistence in the discipline and graduation in the discipline).

Quantity of role models was assessed simply by totaling the number of role models listed by each participant. Participants were given a definition for role model and then asked to list those who fit that description for them. However, due to the complexity of the three-part definition, some participants may not have understood the definition accurately and simply listed people they felt impacted them in some way, regardless of their ability to model skills relevant to STEM. There was no way to ensure participants listed role models who fit the strict definition delineated in the operational definition of this construct. Additionally, using only one number to assess this construct failed to account for the frequency participants interacted with their listed role models. This was assessed but not incorporated into the hypothesized model. Perhaps this may be an important component of role modeling that this study failed to fully investigate.

A revised version of the AWAI was used to assess quality of role modeling relationships. This 14-item modified version was developed from the original 30-item measure and used as an experimental assessment tool. This tool was not psychometrically evaluated before being used in this study. Measurement development should ideally occur before hypothesis testing to ensure the measure holds up psychometrically and can reliably assess the intended construct. Luckily, this measure obtained an adequate coefficient alpha, and it looks very promising at this stage of development.

Due to the nature of this study, all of the measures relied on participant self-report, and most were collected at one point in time. This calls into question the accuracy of the data collected. The sheer length of the combined surveys may also have reduced participant responsiveness, resulting in possible yea-saying or nay-saying response styles toward the end of the survey. To investigate this possibility, scatter plots depicting responses for each measure were analyzed for outliers. No respondents appeared questionable or necessitated removal from the sample.

Future Directions

The findings from this study suggest exciting possibilities for the future of vocational research, specifically with regard to the impact of role modeling relationships on women's career development. Role modeling has rarely been assessed within vocational research, and measurement tools for this construct remain limited. By conducting more studies exploring this construct and developing tools for its measurement, we can begin to delineate some characteristics of effective and impactful role modeling experiences, particularly as they relate to women's vocational development.

In general, the impact of field-specific self-efficacy on vocational goal setting and attainment is accepted within the research literature. However, the influence of role modeling relationships remains on shaky ground and has not been documented frequently. What is it about these types of relationships that is impactful for one's career development? What constructs mediate the relation between role modeling and career aspirations, if any? Researchers would also benefit from an examination of the influence of role modeling relationships on alternate outcome variables, such as persistence in STEM fields. As one can observe, a continued examination of various contextual supports and barriers to women's career development is greatly needed.

APPENDIX A

Directions: Please read the following definition of the term "role model."

Role Model – a person you have admired because they have been able to model skills in science, technology, engineering, or math and to do one or both of the following:

(1) to motivate you to pursue a scientific, technological, engineering, or mathematical field

(2) to help you develop your professional identity in a scientific, technological, engineering, or mathematical field

Directions: After reading this definition, think back to the people in your own life. Based on this definition of a role model, please list UP TO TEN people who you believe fit that description for you. For each of the people you select, list their name, their gender, and their relationship to you. (When indicating each person's relationship to you, refer to them as your mother, your cousin, your teacher, your neighbor, etc.)

After identifying one role model, you will be asked three questions about that particular role model. After answering those questions, you will then be given the opportunity to list another role model. Please continue this process until you are finished listing role models. You may be able to come up with many people, only one person, or none at all. Please include only those people with whom you were familiar BEFORE coming to college.

Role Model #1
Name: __________
Gender: __________
Relationship to You: __________

Directions: Please read the following definitions of the words "desirable," "attainable," and "interact."

Desirable – worth seeking or doing as advantageous or beneficial

Attainable – able to be reached as an end goal

Interact – to communicate in some form on a one-on-one basis

APPENDIX A (CONTINUED)

<u>Directions:</u> For each of the role models you listed, please select the best answer to each of three questions. Please use the definitions we have provided to help you to answer each question.

1. To what degree did a career in science, math, or engineering become more DESIRABLE to you due to exposure to and/or a relationship with this person? (please select one answer)

1	2	3	4
not at all	somewhat	quite a bit	a great amount

2. To what degree did a career in science, math, or engineering become more ATTAINABLE to you due to exposure to and/or a relationship with this person? (please select one answer)

1	2	3	4
not at all	somewhat	quite a bit	a great amount

3. How frequently did you INTERACT with this individual? (select the answer most similar to your experience)

1	2	3	4	5	6
never	at least once/year	at least once every 6 months	at least once/month	at least once/week	at least once/day

This process was repeated for each role model listed, allowing each participant to list a maximum of ten role models. After participants indicated they had finished listing role models, they were asked to complete Appendix B.

APPENDIX B

<u>Directions:</u> Please read the following definition of the term "influential."

<u>Influential</u> – possessing the capability of having an effect on the development of someone

<u>Directions:</u> Of the role models you just listed, please select the ONE person you view as the most influential to you.

Please type their name here: ______________________

<u>Directions:</u> Please select the number on the 5-point scale representing how much you agree with the following statements as they relate to this ONE selected role model.

1	2	3	4	5
strongly disagree		neutral/ not applicable		strongly agree

1. I got the feeling that my role model did not like me very much. *
2. My role model introduced me to professional activities.
3. I did not want to be like my role model. *
4. I tended to see things differently from my role model. *
5. My role model helped me establish timetables for accomplishing major tasks.
6. My role model and I had different interests. *
7. I did not feel respected by my role model. *
8. I felt like my role model expected too much from me. *
9. My role model offered me encouragement for my accomplishments.
10. I did not think that my role model believed in me. *
11. My role model took my ideas seriously.
12. I learned from my role model by watching him/her.
13. I consistently implemented suggestions made by my role model.
14. My role model helped me recognize areas where I could improve.

* = reverse-scored

APPENDIX C

Directions: For each item below, please circle the number on the 10-point scale representing how sure you are of being able to complete the following tasks.

1	2	3	4	5	6	7	8	9	10
completely unsure									completely sure

1. Complete the math requirements for most science, math, or engineering majors.
2. Complete the chemistry requirements for most science, math, or engineering majors.
3. Complete the physics requirements for most science, math, or engineering majors.
4. Complete some science, math, or engineering degree.
5. Perform competently in some science, math, or engineering career field.
6. Remain in a science, math, or engineering major over the next semester.
7. Remain in a science, math, or engineering major over the next two semesters.
8. Remain in a science, math, or engineering major over the next three semesters.
9. Excel in science, math, or engineering over the next semester.
10. Excel in science, math, or engineering over the next two semesters.
11. Excel in science, math, or engineering over the next three semesters.
12. Be accepted into a science, math, or engineering graduate program, law school, or medical school.
13. Successfully obtain a science, math, or engineering graduate degree, a law degree, or a medical degree.
14. Excel in a science, math, or engineering graduate program, a law program, or a medical school program.

APPENDIX D

Directions: For each item below, please circle the number on the 5-point scale representing your agreement with the following statements.

1	2	3	4	5
strongly disagree				strongly agree

1. It is very difficult for a woman to combine a career as a scientist with a family life. *
2. If a woman chemist or physicist takes time away from her career to have children, she will never catch up again. *
3. A woman who is really dedicated to a career in science or mathematics would not be able to devote much time or energy to her family. *
4. Both women and men can find the time they need for the concentrated work that a career in mathematics or science requires, even if they are involved in an intimate relationship (with someone outside of their field).
5. A woman who is considering a career as a mathematician or scientist should probably plan not to have children. *
6. For women, there is nothing incompatible about planning both a family and a top-level scientific career.
7. Most women who are scientists find that, with a little ingenuity and support, they can happily combine their career with having a family.

* = reverse-scored

APPENDIX E

Directions: For each item below, please circle the number on the 5-point scale representing how true each of the following statements is of you.

1	2	3	4	5
not at all true of me				very true of me

1. I hope to become a leader in my career field.
2. When I am established in my career, I would like to manage other employees.
3. I would be satisfied just doing my job in a career I am interested in. *
4. I do not plan on devoting energy to getting promoted in the organization or business I am working in. *
5. When I am established in my career, I would like to train others.
6. I hope to move up through any organization or business I work in.
7. Once I finish the basic level of education needed for a particular job, I see no need to continue in school. *
8. I plan on developing as an expert in my career field.
9. I think I would like to pursue graduate training in my occupational area of interest.
10. Attaining leadership status in my career is not that important to me. *
11. I definitely plan to attend graduate school, law school, or medical school.

* = reverse-scored

APPENDIX F

Directions: Please answer each prompt by filling in the appropriate information or, when applicable, by choosing your answers from the lists provided.

Your Age: ________

Your Current Major: ___________________

Please check the box of the year in college you have most recently completed.
_____ First Year
_____ Second Year

Please check the box of one or more items from the following list you feel best describes your ethnicity.
_____ African American
_____ Asian American/Pacific Islander
_____ Native American/Native Alaskan
_____ Latino/a
_____ Caucasian
_____ International
_____ Other (please specify: ___________________)

Location of High School:
City: _______
State: _______
Country: _______

Number of Students in High School Graduating Class: ________

Please check the box in front of ALL of the classes from the following list you took while in high school.

_____ Algebra I
_____ Matrix Algebra
_____ Algebra II
_____ Trigonometry
_____ Geometry
_____ Analytic Geometry
_____ Probability and Statistics
_____ Pre-Calculus
_____ Calculus
_____ Advanced Placement Calculus
_____ Physics
_____ Advanced Placement Physics
_____ Advanced Placement Biology
_____ Earth Science
_____ Physical Science
_____ Biology I
_____ Meteorology
_____ Biology II
_____ Astronomy
_____ Environmental Science
_____ Botany
_____ Zoology
_____ Marine Biology
_____ Chemistry
_____ Advanced Placement Chemistry
_____ Anatomy and Physiology

APPENDIX F (CONTINUED)

_____ Other (please specify: ____)

Mother's Occupation: ________________

Father's Occupation: ________________

Step-Mother's Occupation (if applicable): ________________

Step-Father's Occupation (if applicable): ________________

Guardian's Occupation (if applicable): ________________

REFERENCES

American Chemical Society. (2001, March). *Women Chemists 2000: Analysis of the American Chemical Society's Survey of the Salaries and Employment Status of its Domentic Members.* Author, Washington, D.C.

American College Test. (1997). *ACT assessment technical manual.* Iowa City, IA: Author.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

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

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

Benbow, C. P., Lubinski, D., Shea, D. L., & Eftekhari-Sanjani, H. (2000). Sex differences in mathematical reasoning ability at age 13: Their status 20 years later. *Psychological Science, 11*(6), 474-480.

Betz, N. E., & Fitzgerald, L. F. (1987). *The career psychology of women.* New York: Academic Press.

Betz, N. E., & Hackett, G. (2006). Career self-efficacy theory: Back to the future. *Journal of Career Assessment, 14*(1), 3-11.

Betz, N. E., & Schifano, R. S. (2000). Evaluation of an intervention to increase realistic self-efficacy and interests in college women. *Journal of Vocational Behavior, 56*, 35-52.

Beyer, S. (1995). Maternal employment and children's academic achievement: Parenting styles as mediating variables. *Developmental Review, 15*, 212-253.

Browne, B. A. (1997). Gender and preferences for job attributes: A cross cultural comparison. *Sex Roles, 37*(1-2), 61-71.

Brownlow, S., Smith, T. J., & Ellis, B. R. (2002). How interest in science negatively influences perceptions of women. *Journal of Science Education and Technology, 11*(2), 135-144.

Brownlow, S., McPheron, T. K., & Acks, C. N. (2003). Science background and spatial abilities in men and women. *Journal of Science Education and Technology, 12*(4), 371-380.

Chusmir, L. H., & Koberg, C. S. (1991). Sex role conflict in sex-atypical jobs: A study of female-male differences. *Journal of Organizational Behavior, 12*, 461-465.

Coleman, S. L., & Gotch, A. J. (1998). Spatial perception skills of chemistry students. *Journal of Chemical Education, 75,* 206-209.

Eccles, J. S. (1987). Gender roles and women's achievement-related decisions. *Psychology of Women Quarterly, 11,* 135-172.

Edlind, E. P., & Haensly, P. A. (1985). Gifts of mentorships. *Gifted Child Quarterly, 29*(2), 55-60.

Fagenson, E. A. (1993). Personal value systems of men and women entrepreneurs versus managers. *Journal of Business Venturing, 8*, 409-430.

Ferry, T. R., Fouad, N. A., & Smith, P. L. (2000). The role of family context in a social cognitive model for career-related choice behavior: A math and science perspective. *Journal of Vocational Behavior, 57,* 348-364.

Fouad, N. A., & Smith, P. L. (1996). A test of a social cognitive model for middle school students: Math and science. *Journal of Counseling Psychology, 43*, 338-346.

Gerdes, E. P. (1995). Women preparing for traditionally male professions: Physical and psychological symptoms associated with work and home stress. *Sex Roles, 32*(11-12), 787-807.

Gibson, D. E. (2004). Role models in career development: New directions for theory and research. *Journal of Vocational Behavior, 65*, 134-156.

Hayden, D. C., & Holloway, E. L. (1985). A longitudinal study of attrition among engineering students. *Engineering Education, 5*, 664-668.

Jussim, L., & Eccles, J. S. (1992). Teacher expectations II: Construction and reflection of student achievement. *Journal of Personality and Social Psychology, 63*, 947-961.

Lankau, M. J., Riordin, C. M., & Thomas, C. H. (2005). The effects of similarity and liking in formal relationships between mentors and protégés. *Journal of Vocational Behavior, 67*, 252-265.

Lent, R. W., & Brown, S. D. (2006). On conceptualizing and assessing social cognitive constructs in career research: A measurement guide. *Journal of Career Assessment, 14*(1), 12-35.

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

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

Lips, H. M. (1992). Gender and science-related attitudes as predictors of college students' academic choices. *Journal of Vocational Behavior, 40*, 62-81.

Lubinski, D., Benbow, C. P., Shea, D. L., Eftekhari-Sanjani, H., & Halvorson, M. B. J. (2001). Men and women at promise for scientific excellence: Similarity not dissimilarity. *Psychological Science, 12*(4), 309-317.

Luzzo, D. A., Hasper, P., Albert, K. A., Bibby, M. A., & Martinelli, E. A. (1999). Effects of self-efficacy enhancing interventions on the math/science self-efficacy and career interests, goals and actions of career undecided college students. *Journal of Counseling Psychology, 46*(2), 233-243.

McManus, S. E., & Russell, J. E. A. (1997). New directions for mentoring research: An examination of related constructs. *Journal of Vocational Behavior, 51*, 145-161.

Meinster, M. O., & Rose, K. C. (2001). Longitudinal influences of educational aspirations and romantic relationships on adolescent women's vocational interests. *Journal of Vocational Behavior, 58,* 313-327.

Melamed, T. (1995). Barriers to women's career success: Human capital, career choices, structural determinants, or simply sex discrimination. *Applied Psychology: An International Review, 44*(4), 295-314.

National Science Foundation, Division of Science Resources Statistics. (2002). *Women, minorities, and persons with disabilities in science and engineering: 2002* (NSF 03-312). Arlington, VA: National Science Foundation.

National Science Foundation, Division of Science Resources Statistics. (2007). *Women, minorities, and persons with disabilities in science and engineering: 2007* (NSF 07-315). Arlington, VA: National Science Foundation.

Nauta, M. N., Epperson, D. L., & Kahn, J. H. (1998). A multiple-groups analysis of predictors of higher level career aspirations among women in mathematics, science, and engineering majors. *Journal of Counseling Psychology, 45*(4), 483-496.

O'Brien, K. M. (1995). *The Career Aspiration Scale.* (Available from K. M. O'Brien, Department of Psychology, University of Maryland, College Park, MD 20742)

O'Brien, K. M. (1996). The influence of psychological separation and parental attachment on the career development of adolescent women. *Journal of Vocational Behavior, 48*, 257-274.

O'Brien, K. M., & Fassinger, R. E. (1993). A causal model of the career orientation and choice of adolescent women. *Journal of Counseling Psychology, 40*, 456-469.

Perrone, K. M., Webb, L. K., & Blalock, R. H. (2005). The effects of role congruence and role conflict on work, marital, and life satisfaction. *Journal of Career Development, 31*(4), 225-238.

Pleiss, M. K., & Feldhusen, J. F. (1995). Mentors, role models, and heroes in the lives of gifted children. *Educational Psychologist, 30*(3), 159-169.

Prediger, D. J., & Swaney, K. B. (1995). Using UNIACT in a comprehensive approach to assessment for career planning. *Journal of Career Assessment, 3*(4), 429-451.

Ragins, B. R., & Scandura, T. A. (1994). Gender differences in expected outcomes of mentoring relationships. *Academy of Management Journal, 37*, 957-971.

Sax, L. J., & Bryant, A. N. (2006). The impact of college on sex-atypical career choices of men and women. *Journal of Vocational Behavior, 68*, 52-63.

Schlosser, L. Z., & Gelso, C. J. (2001). Measuring the working alliance in advisor-advisee relationships in graduate school. *Journal of Counseling Psychology, 48*(2), 157-167.

Scott, A. B., & Mallinckrodt, B. (2005). Parental emotional support, science self-efficacy, and choice of science major in undergraduate women. *The Career Development*

Quarterly, 53(3), 263-273.

Smith, W. S., & Erb, T. O. (1986). Effect of women science career role models on early adolescents' attitudes toward scientists and women in science. *Journal of Research in Science Teaching, 23*(8), 667-676.

Stake, J. E., & Noonan, M. (1985). The influence of teacher models on the career confidence and motivation of college students. *Sex Roles, 12*, 1023-1031.

Swaney, K. B. (1995). *Technical manual: Revised unisex edition of the ACT interest inventory (UNIACT).* Iowa City, IA: American College Testing.

Wallace, J. E. (2001). The benefits of mentoring for female lawyers. *Journal of Vocational Behavior, 58,* 366-391.

Wanberg, C. R., Welsh, E. T., Kammeyer-Mueller, J. (2007). Protégé and mentor self-disclosure: Levels and outcomes within formal mentoring dyads in a corporate context. *Journal of Vocational Behavior, 70*, 398-412.

Williams, C. M., & Subich, L. M. (2006). The gendered nature of career related learning experiences: A social cognitive career theory perspective. *Journal of Vocational Behavior, 69*, 262-275.

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"The only person who is educated is the one who has learned how to learn and change."

- Carl Rogers