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Women in mathematics, science, and engineering college majors: A model predicting career aspirations based on ability, self-efficacy, role model influence, and role conflict

by

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ABSTRACT

This study investigated a model of predictors of career aspirations among two groups of women: students in mathematics, physical science, and engineering majors and students in biological science majors. Based on theories of women's career development and social-cognitive theories, it was hypothesized that ability, self-efficacy, positivity of role model influence, and role conflict would influence the career aspirations of these women. It was further hypothesized that the students' year in school would contribute to this model as a predictor variable. Five hundred forty-six students (representing a 71% response rate) from Iowa State University were surveyed by mail to evaluate the fit of this model.

The structural equation modeling procedure revealed that the career aspirations of the two groups of women were directly predicted by self-efficacy and role conflict and indirectly predicted by year in school, academic ability, and positivity of role model influence. The model for this combined group of students represented a good overall fit, explaining 94% of the covariation among the measured variables. When the two groups of students were compared, identical models for women in the two groups revealed different relationships among the variables. In contrast to the women in math, physical science, and engineering majors, the relationships between ability and self-efficacy and between positivity of role model influence and self-efficacy were significantly lower in magnitude for women in the biological sciences group.

In addition to providing a parsimonious model for conceptualizing the experiences of women in traditionally male fields, this study's findings have implications for increasing the number of women who aspire to advanced careers in these occupations. Primarily, this study suggests that interventions designed to increase the degree to which students are influenced positively by role models may increase their self-efficacy expectations and may decrease the amount of conflict they perceive between the roles of worker and spouse or

parent. In turn, increasing self-efficacy and decreasing role conflict may increase the degree to which students aspire to leadership and top-level careers within mathematics, the physical sciences, and engineering.

CHAPTER 1

INTRODUCTION

Although women make up nearly half of all employed persons in the United States, the work force is stratified by gender (Betz, 1994a; Betz & Fitzgerald, 1987; National Science Foundation [NSF], 1994). Women tend to be highly concentrated in "pink collar" jobs, which are lower-paying, lower-status, traditionally female positions, such as clerical work, nursing, and elementary school teaching (Betz, 1994a; Betz & Fitzgerald, 1987). Although they make up significant proportions of workers in some non-traditional fields, such as business, law, and medicine, women are drastically underrepresented in the physical sciences, mathematics, and engineering (Betz, 1994a; Betz & Fitzgerald, 1987; Dick & Rallis, 1991; Morgan, 1992; United States Department of Labor [USDL], 1994). In 1992, women made up only 9% of engineers, 13% of physicists and astronomers, and 11% of geologists (National Science Board [NSB], 1993).

Precursors of women's underrepresentation in the sciences and engineering begin during the early school years and continue throughout every educational level. Very young children identify some occupations as stereotypically female or stereotypically male (Betz, 1994b; Betz & Fitzgerald, 1987; Gettys & Cann, 1981), and these sex-role expectations seem to affect students' career choices. When high school students are given the option of selecting their own courses, significantly fewer women than men elect to take advanced math and science coursework (Betz, 1994a; Betz & Fitzgerald, 1987; Dick & Rallis, 1991; Educational Testing Service, 1988). In addition, fewer women than men choose science, mathematics, and engineering majors when they enter college (Brush, 1991; NSF, 1994). Those women who do select non-traditional college majors are less likely than men to persist in those majors through graduation (National Research Council [NRC], 1991; NSF, 1994) and are also less likely than men to pursue graduate education in those fields (Betz, 1994b;

Meade, 1991; NSB, 1993, NSF, 1994). At the doctorate level, only about 9% of engineering degrees awarded in 1991 were earned by women (NSB, 1993; NSF, 1994). According to the United States Department of Labor (1994), women's low participation in physical science and engineering doctoral programs represents the major barrier to their achieving equity in these fields because, unless they have advanced degrees, women are not eligible for upper-level management and academic positions.

Increasing the number of female students and employees in the physical sciences, mathematics, and engineering would be beneficial for individual women and for society. Women who have interests in science and engineering would benefit from entering into career fields that are consistent with their personality characteristics (Holland, 1973, 1985) instead of pursuing more traditional careers that may represent a poorer fit with their preferences. In addition, the United States Department of Labor (1994) identified engineering as one of the top five most lucrative occupations for women, suggesting economic advantages for women who pursue non-traditional careers. Society would also benefit from women's increased participation in the science and engineering work forces not only because women would fill vacant positions left by workers of the baby-boom generation (Baum, 1990; Brush, 1991; NRC, 1991), but also because they would bring new perspectives and new ideas to the fields (Wilson, 1992).

Despite acknowledgment of the benefits of increasing women's participation in non-traditional fields, their numbers in the physical sciences, mathematics, and engineering remain very low. This has led many researchers to investigate possible barriers to women's entrance into and persistence in non-traditional fields. Betz and Fitzgerald (1987), Farmer (1976), and Harmon (1977) distinguished between internal barriers, which are characteristics of an individual person that may be influenced by societal sex-role stereotypes, and external barriers, which are characteristics of the environment such as discrimination, harassment, and lack of support. A number of studies have documented the effects of internal and external barriers on women's career development (see Betz & Fitzgerald, 1987, and Lent, Brown, & Hackett, 1994 for reviews).

As discussed below, ability, self-efficacy, role model influence, and role conflict have all received support individually for contributing to an understanding of women's underrepresentation in technical fields. An investigation of the ways in which these variables may influence one another and work together to influence career aspirations holds promise for providing additional understanding of women's persistence in science and engineering beyond the undergraduate level when many women are "lost" from the science and engineering pipeline. The aim of this study was to examine the influence of these interrelationships on aspirations to advance in the highly gender-stratified fields of math, physical science, or engineering and to contrast this with the variables' influence on the career aspirations of women in biological science majors in which women are not as drastically underrepresented. Specification of a theoretical model predicting career aspirations was derived from the research and theory discussed below.

Career Aspirations

Career aspirations, which refer to the extent to which people aspire to leadership or advanced positions within their chosen occupation (Dukstein & O'Brien, 1995), may have particular relevance as an outcome variable for investigations of women's persistence in non-traditional fields. Specifically, high career aspirations, by definition, are held by students who plan to remain highly invested in the field beyond the undergraduate level. Unfortunately, the majority of research has focused on students' participation in science and engineering undergraduate majors and has overlooked the effects of internal and external barriers on decisions to pursue graduate education and careers requiring advanced degrees. Factors influencing the career aspirations of students in science and engineering are needed to help determine what facilitates plans and goals to reach high levels in those fields.

Ability

Research has documented the effects of academic ability on a variety of educational and career outcomes. Meta-analyses have suggested that there is a moderate positive correlation between school grades and occupational success (Barrett & Depinet, 1991). Findings that are particularly important in explaining women's low rates of participation in the sciences and engineering are those linking ability to traditionality of career choice (Fassinger, 1985, 1990; Goldman & Hewitt, 1976), persistence in non-traditional majors (Benbow & Arjmand, 1990; Chipman & Wilson, 1985; Schaefers, Epperson, & Nauta, 1997), and career aspirations (Dukstein & O'Brien, 1995).

In general, it appears that ability plays an important role in women's decisions to enter and persist in non-traditional career fields, but ability alone does not explain the extremely low numbers of women in the sciences and engineering because many women who leave these fields do so with grade point averages that reflect successful academic performance (NSF, 1994). As discussed below, self-efficacy may play an important mediating role in the relationship between ability and women's persistence and aspirations in technical fields.

Self-Efficacy

Bandura (1977, 1982) suggested that self-efficacy expectations, which are a person's beliefs about his or her ability to perform a behavior successfully, may determine whether he or she will initiate a behavior, how much effort he or she will expend, and how long he or she will persist in the face of obstacles. Hackett and Betz (1981) extended Bandura's theory to career behavior, proposing that a person's selection of and persistence in a particular career depends on beliefs about whether he or she has the skills or potential to learn the skills required of workers in that occupation. Hackett and Betz (1981) suggest that, as a result of socialization experiences, women's self-efficacy expectations for non-traditional careers may be low in comparison to men's, accounting for their low representation in those fields.

Much research has supported Hackett and Betz's (1981) claims, and women have frequently been shown to have lower self-efficacy expectations than men, particularly for tasks they perceive as traditionally male (Deaux & Farris, 1977; Eccles, 1984; Matsui, Ikeda, & Ohnishi, 1989; Miura, 1987; Parsons, 1983). Self-efficacy expectations have also been shown to influence the range of students' perceived career options (Betz & Hackett, 1981), consideration of math- and science-related majors (Betz & Hackett, 1983; Lent et al., 1986, 1987) and persistence in engineering majors (Schaefers et al., 1997); a search of existing research yielded no investigations of the direct effects of self-efficacy on career aspirations (i.e., the degree to which a person aspires to leadership or advanced positions within their chosen occupation), although such a relationship is consistent with Hackett and Betz's (1981) predictions.

In addition to its direct influence on various career outcomes, some research suggests that self-efficacy may mediate the aforementioned relationship between ability and those career outcomes. Betz and Hackett (1981), for example, found that women's ACT scores were related to the range of career options they were considering only as mediated by self-efficacy expectations, although Shaefers et al. (1997) found that measures of academic ability were also important direct predictors of persistence in engineering college majors. Thus, it appears useful to consider objective measures of ability as well as students' subjective perceptions of their ability (i.e., self-efficacy expectations) as direct and indirect influences when investigating women's career behaviors.

Role Model Influence

A lack of female role models has been identified as an external barrier to women's entrance into and persistence in non-traditional fields (Basow & Howe, 1980; Betz, 1994b;

Betz & Fitzgerald, 1987; Hackett, Esposito, & O'Halloran, 1989). A role model is a person whose life and activities influence another person in some way (Basow & Howe, 1980), and research has shown that women perceive female role models as playing an especially important role for women who are pursuing non-traditional careers (Berg & Ferber, 1983; Dick & Rallis, 1991; Gilbert, 1985; Lewis, 1991; McLure & Piel, 1978; Smith & Erb, 1986; Subotnik & Steiner, 1992).

The way in which role models influence students is not entirely clear. One hypothesis is that role models may provide important self-efficacy information to students through vicarious learning (Bandura, 1977, 1986). This idea has received support from researchers such as Scherer, Brodzinski, and Wiebe (1991) and Little and Roach (1974) who found that students who had observed a highly successful model in a specific occupational field were more likely to believe that they themselves would be successful in the field and to express a preference for entering that career than were those who had observed an unsuccessful model in that field. Despite its potential for contributing to an understanding of women's beliefs about their ability to succeed in non-traditional fields, there have been no empirical investigations of the influence of role models on self-efficacy in traditionally male occupations.

Role Conflict

Another hypothesis about the way in which role models influence career outcomes is that role models may illustrate ways in which role conflict may be handled. Role conflict occurs when a person perceives that the demands required by work and family roles are incompatible or extremely difficult to combine (Livingston & Burley, 1991), and there is support for the hypothesis that access to effective role models reduces such conflict. Almquist and Angrist (1971) and Gilbert (1985) found evidence suggesting that women who had been exposed to role models with careers and families were more likely to believe that combining work and family demands can be accomplished effectively.

A number of researchers (Arnold, 1993; Betz, 1994b; Betz & Fitzgerald, 1987; Fassinger, 1990; Morgan, 1992; Olsen, Frieze, & Detlefsen, 1990) have suggested that women avoid traditionally male careers because they perceive (perhaps accurately) that these fields allow little freedom to pursue family interests and responsibilities. Because role conflict has been shown to be negatively related to career aspirations (Dukstein & O'Brien, 1995), it seems that models of women's vocational behavior should consider role conflict as a mediating variable. Specifically, successful negotiation of role conflict by role models likely mediates the observed relation between role model influence and career aspirations. Unfortunately, this relationship has not been empirically tested.

Purpose of the Study

In spite of the large quantity of research on factors related to women's career choices, the lack of a unifying theory to describe relationships among variables has made it difficult to determine the relative strength of the variables in their influence on women's career development. A number of researchers (Lent et al., 1994; Fassinger, 1985, 1990; Swanson & Tokar, 1991) have called for a unification of career theories and seemingly diverse factors believed to affect career behavior. Although it has been established that ability, self-efficacy, role model influence, and role conflict individually affect vocational decisions and behaviors, less is known about the ways these variables work together, both directly and indirectly, to influence career outcomes such as career aspirations. The primary purpose of this study was to investigate the simultaneous effects of these factors on the career aspirations of women in the highly gender-stratified undergraduate majors of mathematics, the physical sciences, and engineering. A second question of interest was whether these variables would act in the same way to influence the career aspirations of female students in biological science majors, which historically were made up primarily of male students but which are currently made up of approximately equal numbers of female and male students.

Hypothesized Model

Figure 1 depicts a theoretical model that was investigated via structural equation modeling with latent variables in this study. This model predicted that the relationship between ability and career aspirations would be mediated by self-efficacy expectations, with ability being positively related to self-efficacy and self-efficacy being positively related to career aspirations. It was expected that students' year in school would be positively related to their self-efficacy expectations. The model also predicted that the relationship between role model influence and career aspirations would be mediated by expectations of role conflict and by self-efficacy expectations. It was expected that role model influence would be negatively related to role conflict which, in turn, would be negatively related to career aspirations in science and engineering. Role model influence was predicted to be positively related to self-efficacy expectations. As described above and in greater detail in the review of the literature, each of the predicted relationships was based on theoretical hypotheses and on previous empirical evidence when available.

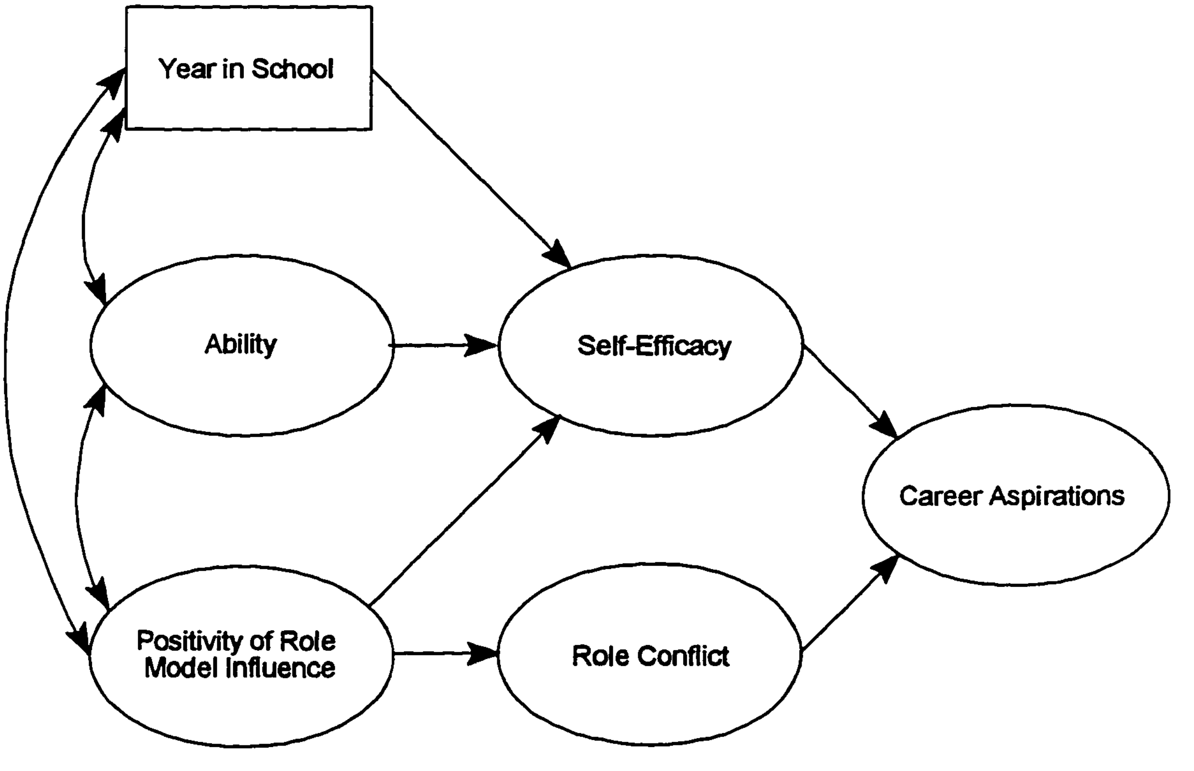

Figure 1. The proposed theoretical model.

CHAPTER 2

REVIEW OF THE LITERATURE

Women's Participation in the Work Force

Prior to the second world war, women in the United States who worked outside the home tended to be the exception rather than the rule. Women's participation in work has increased dramatically since the 1940s, however, and they currently make up approximately 46% of the labor force (U.S. Department of Labor [USDL], 1993; National Science Foundation [NSF], 1994). Moreover, it is expected that 81% of women between the ages of 25 and 64 will be active participants in the work force by the year 2000 (Green & Epstein, 1988). Thus, working women are no longer an exception, and most women plan to and will work throughout a majority of their adult lives (Betz, 1994a).

Although the numbers of women participating in the overall work force have increased, this is not necessarily indicative of their widespread participation in all occupational fields. Women have tended to be highly concentrated in "pink collar" jobs, which are lower-paying, lower-status, traditionally female occupations, such as clerical work, retail sales, nursing, waitressing, library services, housekeeping services, and elementary school teaching (Betz, 1994a; Betz & Fitzgerald, 1987; Eccles, 1994). For example, women made up 87% of librarians and 95% of nurses in 1985 (USDL, 1994), and they comprised 88% of all elementary school teachers in 1991 (National Science Board [NSB], 1993).

Societal changes and an increased acceptance of women working outside the home have led to some broadening in the range of careers pursued by women in recent years, and they now make up significant proportions of workers in some traditionally-male occupations, such as business, law, and medicine (Betz, 1994a; Eccles, 1987). At the same time, women continue to be drastically underrepresented in the physical sciences, mathematics, engineering, and skilled trades (Betz, 1994a; Betz & Fitzgerald, 1987; Dick & Rallis, 1991;

Morgan, 1992; USDL, 1994). In 1992, for instance, only 9% of engineers, 13% of physicists and astronomers, and 11% of geologists were women (NSB, 1993; NSF, 1994).

The disproportionately low representation of women in science and engineering occupations is particularly notable in positions that require advanced degrees. In 1991, women accounted for only 6% of full professors in the natural sciences and engineering in the United States, and they made up only 3% of all doctoral-level employed engineers in that year (Anderson, 1995; NSB, 1993). In fact, among all white-collar occupations, engineering ranks last in the proportion of female workers (Meade, 1991; Robinson & McIlwee, 1991).

Thus, although the extent of women's participation in the work force has now nearly equaled that of men's, the nature of the work in which they are involved continues to be quite different from men's (Betz & Fitzgerald, 1987). It is clear that the work force is still stratified by gender, particularly in technical fields such as the physical sciences, engineering, and mathematics, where women continue to make up only a small percent of employees.

Women's Participation in Physical Science and Engineering Education

The roots of women's underrepresentation in technical fields can be traced to the elementary school years, and low rates of science, mathematics, and engineering participation continue for women throughout every educational level. The path between the time a person initially expresses some interest in science and engineering and the time he or she attains a top level position in the science or engineering work force has been likened to a "pipeline" in that the number of people reaching each successive level becomes fewer and fewer (e.g., Baum, 1990; National Research Council [NRC], 1991; NSF, 1994). As illustrated below by their participation in various levels of science and engineering education, the proportion of women who are "lost" from the pipeline is significantly larger than the proportion of men "lost" at each level, with the end result being very low numbers of women reaching top positions in the fields.

Interest in Science and Engineering during the Elementary School Years

In their discussion of factors affecting women's career development, Betz and Fitzgerald (1987) suggested that, as a result of sex-role socialization, young children assume very early that some careers are more appropriate for men and others are more appropriate for women. Consequently, the range of perceived career options boys and girls see as possibilities for themselves may become limited even at a very young age. Support for this idea has been documented by Gettys and Cann (1981) who found that even two and one-half-year-old children labeled many careers as for men only or for women only. In addition, a survey of San Francisco Bay area children revealed that during the elementary school years, significantly larger proportions of boys (14%) than girls (5%) indicated career aspirations in the sciences and engineering (Eccles, 1987).

Although exposing elementary school children to role models who are pursuing non-traditional careers has been shown to increase students' positive attitudes toward the pursuit of non-traditional careers (Smith & Erb, 1986), the small number of female role models in the sciences and engineering often limits the opportunities children have to see women succeeding in these non-traditional fields (Betz & Fitzgerald, 1987). It is clear that even during the early school years when children's exposure to math and science course work has been nearly identical, fewer girls than boys indicate an intent to pursue science and math endeavors in school and work. These intentions are then manifested dramatically in high school men's and women's selections of science and math course work.

Women's High School Preparation for Science and Engineering

It has been shown that, beginning in high school, as soon as students have the opportunity to choose their own courses, women elect fewer advanced math and technical science courses than do men (Betz, 1994a; Betz & Fitzgerald, 1987; Dick & Rallis, 1991; NRC, 1991). In 1988, for example, whereas almost all college-bound women and men reported having taken biology, only 35% of women versus 51% of men had taken physics. While 21% of college-bound senior men had taken calculus, only 15% of college-bound women had completed this course. Finally, the National Science Foundation (1990) reported that 16% of high school men in 1990 had taken more than four years of math, whereas only 11% of high school women had taken such intensive mathematics coursework.

The importance of high school mathematics and science course work has been called a "critical filter" in the pursuit of scientific and technical careers because only students who have adequate math and science backgrounds meet the eligibility requirements to pursue science and engineering majors while in college (Sells, 1980). In 1988, 28% of high school men had taken enough math to be able to pursue a collegiate science major, whereas only 22% of high school women had sufficient high school math preparation (NSF, 1994). Thus, the decision to take only the minimal math and science requirements in high school could effectively limit many career opportunities for young women even before they begin college (Dick & Rallis, 1991).

The choice of high school women to take fewer math and science courses than their male counterparts seems to be unrelated to academic ability as measured by school grades. Throughout the elementary and high school years, female students tend to have higher grade point averages than do male students, both overall and in the sciences and mathematics (Betz & Fitzgerald, 1987; NRC, 1991). Dick and Rallis (1991) found that, among groups of equally talented high school men and women who had similar math and science preparation, only 19% of women compared to 64% of men indicated career interests in engineering or science. Further, a more recent survey of 1992 college-bound seniors mirrored Dick and Rallis' (1991) findings, with women being three times less likely than equally capable men to say they were pursuing a career in science, mathematics, or engineering (NSF, 1994). A disturbing finding in the National Science Foundation (1994) study was that higher percentages of female students than male students reported having been advised by guidance counselors not to take senior mathematics (34% of women, 26% of men) or advanced science (32% of women, 26% of men).

Women's Participation in Undergraduate Engineering Majors

Consistent with their choices to enroll in high school science and mathematics courses in lower numbers, female students' selections of these courses at the college level also occur in smaller percentages than do male students'. Only a third as many women as men choose science majors when they enter college (Brush, 1991; Seymour, 1995), and even for those students who initially select college majors in the sciences and engineering, larger proportions of women than men switch to other majors prior to graduation (NSF, 1994; NRC, 1991; Seymour, 1995). In 1985, for example, 35.6% of female freshmen enrolling in engineering programs dropped out of engineering prior to their sophomore year, compared to only 16% of the male freshmen engineering majors who dropped out of engineering programs that year (NRC, 1991).

As a consequence of lower rates of initial selection of and higher rates of attrition from science and engineering majors, significantly fewer women than men receive undergraduate degrees in these departments. In 1987, even though women comprised a majority of undergraduate students, they earned only 15.2% of the undergraduate degrees in engineering, 16.1% of those in physics, 37.2% of those in chemistry (Lips, 1992). These figures remained similar over the next five years, with women earning only 15% of all the bachelor's degrees awarded in engineering in 1991 (NSF, 1994).

Women's Participation in Engineering Graduate Programs

Women's underrepresentation in engineering education becomes even more pronounced at higher educational levels because women are significantly less well-represented in the sciences and engineering at the graduate level than at the undergraduate level (Betz, 1994b). Ehrhart and Sandler (1987) reported that women earned 39%, 44%, and 27% of the bachelor's degrees in agriculture, mathematics, and the physical sciences, respectively, in 1983. The percent of doctorate degrees earned by women in those same fields that year was, respectively, only 14%, 16%, and 14%, suggesting significant declines in the numbers of women represented at the top educational levels. More recent figures suggest that a similar trend continues to hold for women in engineering fields. Despite earning approximately 15% of the bachelor's degrees and 14% of the master's degrees in engineering in 1991 (NSF, 1994), women earned only 9% of the doctorate degrees issued in engineering in that year (NSB, 1993; NSF, 1994).

Women's low participation in graduate education is not constant across all areas of study. In fact, women in 1991 received over 50% of the social science degrees at the doctoral level and 68% of the doctorates in home economics (NSB, 1993). Nor does their low participation in graduate education in the sciences and engineering appear to be due to the fact that these are non-traditional fields; women represented approximately 34% of medical students and 40% of law students during 1991 (NRC, 1991). Of all academic fields, engineering has the lowest proportion of women who earn doctorate degrees (NSB, 1993).

Thus, women's representation in the physical sciences, math, and engineering is low in comparison to men's at every educational level and declines significantly at the doctoral level (Meade, 1991; NRC, 1991). Although interventions designed to increase their participation at any educational level would likely be of value, the United States Department of Labor (1994) reported that doctoral productivity represents the major barrier to women's achieving equity in the science and engineering educational environments and work forces because without advanced degrees, women will not attain upper-level positions in academia and industry. Efforts designed to identify factors that encourage women to aspire to high levels of education in the sciences and engineering would, therefore, have many benefits at this time.

Benefits Associated with Increasing Women's Participation in Science and Engineering

Issues affecting the retention of women in the physical science, math, and engineering "pipeline" have become extremely important for students, educators, employers, and those who study women's career development. The desire to increase the numbers of women who work in these disciplines stems largely from an awareness of costs associated with women's low participation in engineering and the sciences and an awareness of the benefits associated with increasing their participation. There are many ways in which increasing women's participation in the sciences and engineering would be beneficial both for society and for individual women.

Societal Benefits of Women's Pursuit of Non-traditional Careers

Increasing the number of women who enter into and persist in the science and engineering work forces may be very important to society because some experts project a shortage of technical personnel in the future and are troubled by demographic information indicating that the traditional pool from which future engineers and scientists are drawn--young white male students--is shrinking (e.g., Baum, 1990; Brush, 1991; NRC, 1991). These experts call for the recruitment of women and minorities to fill vacancies expected to be left by retiring workers of the baby-boom generation (Brush, 1991; NRC, 1991). In fact, Anderson (1995) projected that the proportion of women and minorities making up engineering undergraduate students (combined, currently 25%) will need to increase to 75% just to maintain the current number of engineers graduating with a bachelor's degree in that field.

In addition simply to filling vacant positions in the physical science and engineering work forces, however, women are needed in these fields in other ways. Current science, math, and engineering employees tend to be a rather homogeneous population of white males. It is argued that diversifying the characteristics of employees in these fields by including larger proportions of women and minorities would bring new questions, ideas, and perspectives to old problems, inspiring technological growth (Wilson, 1992). If the United States is to remain a leader among the world's nations in technological development, these new perspectives would be invaluable (Meade, 1991).

Finally, increasing the numbers of women in the sciences and engineering may prevent gender stratification of the work force from being maintained long into the future. It has been argued that a significant barrier to reducing this stratification is the low number of visible non-traditional employees from which new generations of students may acquire information (Betz & Fitzgerald, 1987). Until the numbers of women employed in the non-traditional fields of science and engineering increase, America's children will likely continue to believe that certain professions are more suited for members of one gender over another, thereby limiting the range of their perceived career options. Interventions designed to increase women's presence in non-traditional fields would, therefore, benefit society not only in the present, but also in the future.

Benefits of Non-traditional Career Choices for Women

Individual women would also benefit from increasing their numbers in non-traditional fields such as engineering and the physical sciences. A number of experts (e.g., Betz, 1994b; Betz & Fitzgerald, 1987; Meade, 1991) have argued that the economic benefits of participation in the sciences and engineering would be of value to individual women. Because women are poorly represented in high-level occupational positions, they have earned substantially lower levels of income than their male counterparts (Eccles, 1987). The average woman's salary is less than the average man's salary (Meade, 1991; Betz, 1994b; Betz & Fitzgerald, 1987; USDL, 1990). In 1991, for example, women with college educations earned, on average, 90 cents for every dollar earned by a man of similar age and education (Hanson & Pratt, 1995). Individual women would benefit from participating in non-traditional career fields because they would likely earn higher salaries than if they were to pursue traditionally female occupations. In fact, the U. S. Department of Labor (1990) identified engineering as among the top five most lucrative occupations for women, thereby supporting the idea that increasing their numbers in this field would be of benefit for them.

In addition to economic benefits associated with pursuing non-traditional careers, there would be psychological benefits (Betz, 1994b; Betz & Fitzgerald, 1987; Eccles, 1987). Currently, many women may be limited in the range of careers they see as viable options for themselves (Betz, 1994b). Although these women may simply be more interested in the tasks, ideas, and content of traditionally female careers, it is also true that many do actually have interests in the sciences and engineering. If those women perceive for some reason that they are unable to participate in careers in those fields, they may pursue careers in which they have less intrinsic interest, thereby decreasing the likelihood that they will be highly satisfied in their careers. Freeing these women to pursue occupations that are consistent with their interests would likely be of benefit to them (e.g., Holland, 1973, 1985).

For women who have interests in the sciences and engineering, increasing the degree to which they are able to pursue career opportunities in these fields would likely have positive effects on their overall life satisfaction as well. Betz and Fitzgerald (1987) suggested that women who lower their career aspirations because of societal sex-role expectations will experience dissatisfaction and disappointment. In support of this hypothesis, a study by Arnold (1993) investigated the experiences of high school valedictorians over 15 years following their high school graduation. This research found that, for women who had expressed an interest in science and mathematics 15 years earlier, those who had not pursued careers in those fields were less satisfied and felt less fulfilled than women who had obtained careers in science and engineering.

It is clear, then, that there would be many potential benefits associated with increasing the number of women who pursue and remain actively involved in physical science, math, and engineering careers. It is also clear that, despite widespread acknowledgment of the benefits of increasing women's participation in these fields, their actual numbers are still low. Identifying and removing barriers to women's pursuit of non-traditional careers, therefore, has been and continues to be an important area of research investigation among psychologists and other professionals who are interested in women's vocational development.

Barriers to Women's Participation in Science and Engineering

A number of researchers have discussed barriers to women's persistence in non-traditional fields like the sciences and engineering, and previous studies have identified many factors believed to contribute to the underrepresentation of women in traditionally male fields. Betz and Fitzgerald (1987), Farmer (1976), and Harmon (1977), for example, discussed external and internal barriers to women's career development. External barriers are characteristics of the environment such as discrimination, sexual harassment, lack of same-sex role models, and lack of social support. Internal barriers, on the other hand, are often influenced by societal sex-role expectations and are characteristics of the individual person, such as low self-efficacy, low self-esteem, self-depreciating attributional styles, and perceived conflict between family and career roles and responsibilities.

The identification of internal and external barriers has provided an impetus for many investigations of women's experiences in traditionally male educational and career fields. Swanson and Tokar (1991) and Fassinger (1990) suggested that the internal-external dichotomy is helpful because it has inspired much theorizing about the various barriers that may affect women's career development. Several internal and external barriers have received research attention, and many investigators (see Lent, Brown, & Hackett, 1994 for a review) documented the effects of such barriers on women's career development. As Swanson and Tokar (1991) and Fassinger (1990) have pointed out, however, it is unfortunate that a relatively small amount of research effort has been directed toward providing an understanding of how these variables may act in combination and interact with one another. Among the variables that individually have received some support for affecting women's pursuit of careers in the sciences and engineering are ability, self-efficacy, role model influence, and role conflict. The direct influences of each of those variables on women's career development are discussed below. In addition, any documented support for the influence of these variables on one another and the ways in which they may act in combination with one another to influence women's experiences in non-traditional career fields are described.

Ability

Academic ability has been shown to be directly related to a variety of educational outcomes throughout the school years as well as to a variety of occupational outcomes. In a comprehensive review of the literature, Barrett and Depinet (1991) concluded that meta-analyses and diverse individual studies have consistently demonstrated a moderate positive correlation between school grades and occupational success. Findings that are particularly relevant for women's career development are those that have suggested that academic ability is related to the traditionality of a person's career choice (e.g., Fassinger, 1985, 1990; Goldman & Hewitt, 1976) and persistence in non-traditional fields of study (e.g., Benbow & Arjmand, 1990; Chipman & Wilson, 1985; Schaefers, Epperson, & Nauta, 1997).

Ability and Traditionality of Career Choice

Career development is clearly affected by a person's initial choice of a college major, and ability has been shown to be an important determinant of the choice a person makes. For women, academic ability seems to be related to a decision about whether to pursue a traditional or non-traditional college major. Goldman and Hewitt (1976) documented evidence that mathematics ability, as measured by quantitative SAT scores, was positively related to college students' choice of a science versus nonscience college major. Although this relationship held for students of both genders, it was particularly strong for women. More recently, Fassinger (1985, 1990) found a similar relationship between ability and traditionality of career choice, with higher standardized test scores and higher grade point averages being predictive of non-traditional career choices for women. Because technical science and engineering programs often have higher academic entrance requirements than other fields of study, the finding that ability is related to the selection of such majors is not entirely surprising. This relationship is, nevertheless, an important one to note because it may effectively limit the number of students, both men and women, who initially attempt physical science, math, and engineering college majors. As discussed in greater detail below, however, women whose high standardized test scores and grade point averages would predict success in engineering and science often believe they lack sufficient ability for these fields, suggesting that the relationship between ability and selection of science majors may be a barrier women perceive as they consider science and engineering careers.

Ability and Persistence in Quantitative Fields of Study

After their initial selection of quantitative fields of study, academic ability appears to continue to play a role in students' persistence in those majors. Chipman and Wilson (1985), for example, found that measures of mathematics ability and achievement, as measured by a combination of college grade point average and SAT scores, were strong predictors of persistence in science, engineering, and mathematics college majors through graduation. In addition, Schaefers et al. (1997) found that measures of academic ability made the strongest contribution to a model of persistence in engineering when compared with measures of self-efficacy, expectancy-valence, support/barriers, and interest congruence. Again, this relationship is not surprising, given that quantitative fields of study tend to be demanding, and students with high academic ability are more likely to maintain acceptable grade point averages in sequences of difficult courses. As discussed below, however, it is important to consider students' perceptions of their academic ability because women whose high standardized test scores and grade point averages would predict successful completion of science and engineering programs often report believing that they lack sufficient ability to enter and persist in these fields.

Limitations of Ability as a Predictor of Women's Persistence in Science and Engineering

Despite clearly having an impact on women's career choices and persistence in technical fields, ability alone cannot fully explain the lower persistence rates of women than men in science and engineering fields. It has been shown that women's academic ability, as measured by grade point average in the sciences and engineering, often surpasses men's. Nevertheless, women often have higher rates of attrition from these college majors (Seymour, 1995). Meade (1991), for example, found that among the women who dropped out of engineering programs, the mean grade point average was 3.2; many men, in contrast, continued on through the programs with grade point averages that were significantly lower than the average for women who dropped out of the field. In addition, the National Science Foundation (1994) found that among engineering students in 1991, 63% of women, compared to 43% of men, had grade point averages of B or better. Nevertheless, women had higher rates of attrition from engineering. This trend seems to be true even for highly talented women. Arnold (1993) and Benbow and Arjmand (1990) found that gifted women had much higher rates of attrition from science and mathematics majors and careers despite surpassing men's academic records. Thus, even when female students--most of whom are outstanding high school students--choose to study engineering and science in college, their dropout rate is much higher than their strong SAT scores and grade point averages would predict (Baum, 1990).

In summary, it is clear that ability does play a role in students' choices of college majors and careers, and ability also seems to play a role in their decisions about whether or not to remain in physical science, mathematics, and engineering career fields, particularly for women. Nevertheless, ability alone does not seem to explain the low persistence rates of women in non-traditional careers. As discussed below, what may be more important than actual ability are women's beliefs and expectations about their academic ability.

Self-Efficacy

Self-efficacy expectations, which are a person's beliefs about his or her ability to perform a given task or behavior, are believed to be important factors in determining behavior and behavior change in many domains (Bandura, 1977, 1982), and they have often been investigated as an internal barrier to women's career development in non-traditional fields (Betz, 1994b; Betz & Fitzgerald, 1987; Farmer, 1976; Harmon, 1977; Schaefers et al., 1997). According to Bandura (1977, 1982), efficacy expectations determine whether or not a person will initiate a behavior, how much effort he or she will expend, and how long he or she will sustain the behavior in the face of obstacles and aversive experiences. For example, if a student believes she is unlikely to be successful at a task, her low self-efficacy expectations may prevent her from attempting to perform the task even if she is relatively certain that performance of the task would lead to desired outcomes. If she does attempt the task, self-efficacy theory suggests she would be less likely than a person with higher self-efficacy to exert a high degree of effort or persistence.

Bandura (1977) described four sources of information through which self-efficacy expectations are acquired and by which they can be modified: performance accomplishments, vicarious learning, verbal persuasion, and emotional arousal. Performance accomplishments are actual experiences a person has had that provide information about his or her ability to be successful at a given task, and this type of information is believed to contribute most strongly to a person's self-efficacy. An example of self-efficacy beliefs acquired through performance accomplishments is a student's assumption that because he or received A grades on exams in high school, he will also do well in math courses in college. A second source of information is acquired through vicarious learning, or watching another person perform a behavior. A student may believe, for example, that because her older sibling did well in engineering courses, she also has the potential to do well in such courses. Verbal persuasion occurs when a person is influenced by encouragement or support from an important other person. A student who receives encouragement from a high school guidance counselor to continue taking science courses because the counselor believes the student has the potential to contribute to the field is an example of this type of information. Finally, a student may acquire information through emotional arousal, which is an intense emotional reaction to an event. A student who becomes distressed by failing his first college exam, for instance, may believe he does not have what it takes to do well in college. All four sources of information may influence a person's self-efficacy beliefs and have been shown to be important determinants of a person's behavior (Bandura, 1982).

Extension of Self-Efficacy Theory to Career Behavior

Hackett and Betz (1981) extended Bandura's theory to career behavior, hypothesizing that a person's beliefs about his or her ability to perform successfully in a particular field will play an important role in determining whether that person will choose a career and whether he or she will persist in that career field. They believe self-efficacy expectations may be especially important to consider when attempting to understand women's career development. As a result of socialization experiences, Hackett and Betz (1981) suggest, women's self-efficacy expectations may be very different from men's. Indeed, research has documented gender differences in self-efficacy in a number of different content areas and tasks.

Gender Differences in Self-Efficacy

In general, it appears that women often have lower levels of self-efficacy for a variety of tasks than do men. Women's tendency to rate their ability lower is especially dramatic on stereotypically masculine tasks, despite the fact that their actual ability on such tasks is often equivalent (e.g., Deaux & Farris, 1977; Miura, 1987; Parsons, 1983). Past research has shown, for example, that girls do as well in math as boys throughout the elementary school years, yet they do not expect to do as well in the future nor are they as likely to go on in math as are boys (Eccles, 1984). Post-Kammer and Smith (1986) found similar results in a sample of high school students, reporting that young women had lower levels of self efficacy than men for three math/science careers. In contrast, these researchers found no gender differences in self-efficacy for non-math/science careers.

The findings that women's and men's reports of self-efficacy expectations are similar for gender-neutral and stereotypically female tasks but that women's self-efficacy expectations for traditionally male tasks are much lower have also been documented in samples of college students. Betz and Hackett (1981), for example, demonstrated that while men had equally high levels of self-efficacy for traditionally male and traditionally female tasks, women had significantly lower levels of self-efficacy for traditionally male tasks. These findings were replicated in a sample of Japanese students. Matsui, Ikeda, and Ohnishi (1989) found that Japanese men reported equivalent self-efficacy in male-dominated and female-dominated occupations, whereas Japanese women reported higher self-efficacy in female-dominated occupations but lower self-efficacy in male-dominated occupations.

Gender differences in self-efficacy despite equivalent ability suggest that, consistent with Hackett and Betz's (1981) theory, the subjective meaning and interpretation of success and failure--not always just the objective outcome--may be important in determining an individual's career behaviors. Indeed, empirical research has supported many of Hackett and Betz's (1981) theoretical claims. As described below, self-efficacy has been found to be predictive of important career criteria such as perceived career options (Betz & Hackett, 1981, 1983; Lent, Brown, & Larkin, 1986), academic grades and persistence (Lent et al., 1984, 1986, 1987; Schaefers et al., 1997), and selection of science-based college majors (Betz & Hackett, 1983).

Self-Efficacy and Perceived Career Options

Self-efficacy expectations seem to be related to the type and number of occupations a person considers. Betz and Hackett (1981) found that ACT scores of women were related to the range of career options they were considering only indirectly through self-efficacy expectations. Among male students, on the other hand, ACT math scores were both directly and indirectly related to the range of career options being considered.

Math and science-related self-efficacy may be especially important determinants of consideration of science and engineering careers (Lent et al., 1987). In a sample of college women, Betz and Hackett (1983) found that math self-efficacy was important in predicting consideration of a science major. Lent et al. (1986) found academic self-efficacy to be related to the range of engineering occupations male and female students consider. A study by Jacobowitz (1983) found similar results, with black junior high school students who had high science self-efficacy being significantly more likely to be considering a science career than those who had low science self-efficacy expectations. Finally, Parsons (1983) found high school students' math self-efficacy to be predictive of plans to enroll in mathematics courses in college.

Self-efficacy does appear to affect students' consideration of a number of college majors and careers, and some research has suggested that self-efficacy may be even more important than actual ability in contributing to an understanding students' career choice patterns. Hackett and Betz (1989) found that mathematics-related self-efficacy expectations were stronger predictors of students' choices of mathematics-related majors and careers than mathematics performance or past mathematics achievement. In a comprehensive review of the many studies, Hackett (1985) reported that there is support for the view that mathematics-related self-efficacy is more strongly predictive of math-related major and career choices than ability, math background, or gender alone or in combination.

Self-Efficacy and Academic Performance

Self-efficacy expectations also seem to be related to a variety of academic performance indices, such as school grades. Lent et al. (1984) found that students who reported relatively strong academic self-efficacy had much higher college grade point averages than those with low self-efficacy. Wood and Locke (1987) further clarified the relationship between self-efficacy and academic performance by showing that self-efficacy was significantly related to self-set academic grade goals and that grade goals, in turn, were related to course performance in college. More recently, Hackett, Betz, Casas, and Rocha-Singh (1992), in a study of college students in engineering majors, found that self-efficacy for a variety of academic tasks was strongly predictive of students' grade point averages in the following semester.

Self-Efficacy and Academic Persistence

Self-efficacy expectations may help explain the differential rates of persistence in the physical sciences, math, and engineering for male and female students (Betz & Hackett, 1983). Lent et al., (1984), for instance, found that students who reported strong academic self-efficacy expectations were much more likely to persist in technical or scientific majors over a one-year period than were students with low academic self-efficacy expectations. In addition, Lent et al. (1987) found that self-efficacy was the best predictor of persistence in technical/scientific majors when compared to interest congruence and consequence thinking. Similarly, Schaefers et al. (1997) found that math self-efficacy was an important predictor of persistence in undergraduate engineering majors. Finally, Deboer (1984) found that a sense of competence was an important factor in the decisions of college students to continue taking additional science courses during the next academic semester.

Brown, Lent, and Larkin (1989) have suggested, however, that the influence of self-efficacy beliefs on academic persistence may depend on the way in which the construct is operationalized and measured. They distinguished between two types of academic self-efficacy: expectations about attaining specific academic milestones (AM-S), and expectations about fulfilling technical/science educational requirements (ER-S). These researchers found self-efficacy expectations for attaining specific academic milestones en route to technical/scientific degrees to have consistently powerful direct effects on grades and persistence for both high- and low-aptitude students. In contrast, the more general beliefs about ability to meet technical/science educational requirements seemed to have moderating effects on academic performance. Low-aptitude students who had high general self-efficacy beliefs persisted in technological college majors for a mean of 3.13 academic quarters following initial assessment, compared to a mean of 1.78 academic quarters for students low in general self-efficacy for educational requirements. For high-aptitude students, however, persistence seemed to be unrelated to their general self-efficacy for educational requirements beliefs.

In summary, self-efficacy plays a role in students' career development, and it may play a particularly important role in women's career behavior. The results of research by Brown et al. (1989) suggest that assessing self-efficacy for specific academic milestones as well as self-efficacy for technical/science educational requirements may be useful in aiding our understanding of issues that affect women's decisions to pursue and to persist in science and engineering college majors.

Role Model Influence

Another variable that has been identified as an external barrier to women's entrance into and persistence in non-traditional fields is a lack of female role models (Basow & Howe, 1980; Betz, 1994b; Betz & Fitzgerald, 1987; Douvan, 1976; Farmer, 1976; Hackett & Betz, 1981; Hackett, Esposito, & O'Halloran, 1989; Harmon, 1977; O'Leary, 1974). A role model is someone whose life and activities influence another person in specific life decisions, such as career choice and behavior decisions (Basow & Howe, 1980). The kinds of role models hypothesized to influence women's career development include teachers, parents and family, spouses, employees in career fields the woman is considering, and other significant adults (Almquist & Angrist, 1971; Basow & Howe, 1980; Betz & Fitzgerald, 1987). As described below, a role model's influence may be positive or negative, and it is hypothesized that a lack of positive female role models in the sciences and engineering makes it difficult for many women seriously to consider careers in these fields (Baum, 1990). Indeed, research has indicated that the presence or absence of role models may affect a woman's work status (Astin, 1968), choice of career (Baum, 1990; Dick & Rallis, 1992; Meade, 1991), and persistence in science and engineering fields (Berg & Ferber, 1983; Lewis, 1991; Subotnik & Steiner, 1992).

The Nature of Role Model Influence

Although it is widely recognized that role models may influence a woman's career behavior, the exact nature and relative impact of various role models on different aspects of the career development process remains unclear (Hackett et al., 1989). The distinction between positive versus negative role model influence and the distinction between same-sex versus opposite-sex role model influence may be important to consider when attempting to understand the role modeling process and how it affects women's career development (Basow & Howe, 1979, 1980).

Positive versus negative influence. Role models may influence others in a way that is positive or negative. The influence of a role model is considered to be positive when the person influenced by the model actively wants to be like him or her in one or more ways (Basow & Howe, 1979, 1980). For example, a high school student who meets a female engineer during a career conference may respect the engineer's dedication to her job and may want to emulate that aspect of her behavior. The influence may be negative, on the other hand, when the person being influenced by the model actively attempts not to be like him or her (Basow & Howe, 1979, 1980). A young woman may, for instance, feel abandoned by a father who tends to immerse himself in his job, and she may actively decide that work will play a relatively unimportant role in her own adult life. Both positive and negative influences from role models are believed to be important in women's career development (Basow & Howe, 1980; Betz, 1994a, 1994b; Betz & Fitzgerald, 1987).

Same-sex versus opposite-sex role models. Another important variable in research on role modeling is the gender composition of the dyad made up by the role model and the person being influenced by the model. Maccoby and Jacklin (1974) found that individuals are more likely to emulate models they perceive as similar to themselves than individuals they perceive as very different from themselves. Perceived similarity is particularly important for characteristics the person being influenced considers salient to the situation in which the model is being observed (Maccoby & Jacklin, 1974). In situations in which young women are considering occupations or college majors that are male-dominated, the gender of role models is one characteristic that may be highly influential.

Indeed, research has tended to support the idea that the gender of a role model may affect the amount and type of influence he or she exerts on others. Previous studies have indicated that men and women do not differ significantly in the amount of influence they say they receive from role models regarding certain life decisions, but women and men may be influenced differentially by specific people (Basow & Howe, 1980). Although women report being equally influenced by male and female role models, women tend to be more influenced than men by female models. Basow and Howe (1980), for example, found that female students were more highly influenced by their mothers as role models than were male students. During the college years, Gilbert (1985) found that female graduate students rated role model relationships as more important to their professional development than did male graduate students. Gilbert's (1985) findings also suggested that students may consider gender heavily when selecting role models. She reported that 75% of the graduate students in her study had selected a same-sex role model; this was true for female graduate students in spite of the fact that women faculty members were much less available as mentors than were male faculty mentors, suggesting that the female students actively sought out women as role models. In many traditionally male fields, in fact, women may have to work very hard to find female role models. The National Science Foundation (1994) reported that university and college faculty in 1990 were overwhelmingly male in every engineering discipline. For example, in mechanical engineering, women comprised only 4% of faculty members (NSF, 1994).

The Influence of Role Models on Women's Career Behaviors

The influence of role models on a woman's career development may begin as early as the elementary school years and continue on throughout her life. Studies have illustrated ways in which role model influences affect women in various ways and at various stages as they participate in the world of work.

Role model influence on general work status. Although most women eventually enter the work force at some point in their lives, mothers as role models seem to have some influence on their daughters' decisions to pursue a career. Almquist and Angrist (1971) and Basow and Howe (1980) found that young women whose mothers were employed as they grew up were much more likely than young women whose mothers did not work to say that they themselves were pursuing a career. These researchers' findings suggest that children begin to be influenced in their career development by important others in their lives at a very early age.

Role model influence on traditionality of women's career choices. It appears that role models may also affect the traditionality of the careers young women choose for themselves. This influence may begin as early as the elementary school years when children are beginning to learn about and consider various careers. Smith and Erb (1986), for example, found that boys and girls in elementary school reported more negative attitudes toward woman scientists than toward women pursuing more traditional careers. As part of their educational curriculum, however, these researchers exposed the children to women scientists as role models, and they reported that the children's attitudes toward woman scientists and toward science in general became significantly more positive.

During the middle school years, students seem to be aware of the presence or absence of role models in various fields. McLure and Piel (1978) asked junior high school men and women to indicate reasons for women's underrepresentation in science and engineering fields, and a lack of female role models was a reason frequently cited by the adolescents, both male and female. These results suggest that young women not only are influenced by role models, but also that they recognize the importance of this influence on women's career choices.

The influence of role models on their career development seems to be manifested in the traditionality of the careers women eventually do choose for themselves. A number of researchers (e.g., Baum, 1990; Meade, 1991) have observed that more than half of the women who are working as engineers or who are students in engineering programs have at least one family member who is an engineer. Typically, this person is an older brother or father (Meade, 1991), suggesting that male role models may also play a facilitative role in women's decisions to pursue non-traditional careers. Hackett et al. (1989), on the other hand, found male role model influences to be significantly, but negatively, related to college women's choice of a science-related college major. Although these findings might seem to conflict with Baum's (1990) and Meade's (1991) findings, it is important to note that Hackett et al.'s (1989) study involved students in an all-female institution. The authors point out that replication of their study with senior women from a co-educational institution would be necessary to clarify the relationship between male role model influence and college women's choice of science careers. One possibility is that the Influence of Role Models Scale (Basow & Howe, 1975) used in Hackett et al.'s study may assess social support provided by various role models. With much more access to female models in an all-female institution, the women in this study may simply have been contrasting the amount of social support they received from women versus men while in school, rating the influence of male models as negative because it was less than the support received from female models.

There is also some evidence that role models play a more important role in the lives of female students who are pursuing non-traditional careers than for women pursuing traditional careers. Dick and Rallis (1992) examined the influence of role models on students who were highly academically talented and who had sufficient math and science preparation in high school to be eligible for science and engineering college majors. They found that female students who were planning a career in engineering or science were significantly more likely than women planning more traditional careers to indicate having been influenced by a teacher in their career choice.

Role model influence on academic achievement and aspirations. The college years may be another time in which having same-sex role models is particularly important for a woman's career development in that it may affect academic achievement. Gilbert (1985) found that female graduate students who reported having female professors as role models displayed higher levels of academic achievement than those who reported having male professors as role models or those who reported having no role models. In addition, there is some evidence suggesting that the effects of the role model relationship during the college years may be long-lasting. Tidball (1973) and Goldstein (1979) both found a positive relationship between female students' achievement behavior after graduation and their reports of having had female professors as role models during college.

Role model influence may also be associated with educational and career aspirations. Hackett et al. (1989) found that the influence of female teachers was associated with career salience and educational aspirations of a sample of senior college women. Those women who perceived themselves as having been highly influenced by female teachers tended to aspire to higher levels of education and to score higher on a measure of career salience than did women who did not see themselves as having been highly influenced by female teachers.

Influence of role models on women's persistence in non-traditional fields. Finally, there is some evidence suggesting that role models play an important role in determining whether or not a woman will persist in a non-traditional field. Berg and Ferber (1983), Lewis (1991), and Subotnik and Steiner (1992) all found that the influence of a mentor significantly increased the likelihood that a woman would remain in science or engineering fields. There is some ambiguity in determining whether these findings represent the influence of the mentor as a role model, the influence of the mentor as a source of social support, or some other type of influence. As discussed below, there are several possible ways in which role models may be important for women.

Importance of Role Models for Women

It seems clear that role models do play an important role in many women's career decisions and behaviors, and this appears particularly true for women who are pursuing non-traditional careers. What is less clear, however, is exactly what it is about the influence of role models that is important for women. According to Betz (1989) and Freeman (1979), role models may be particularly important for women students because of the "null environment," which is one that neither encourages nor discourages members of either sex. Betz (1989) suggests that such environments are often typical of educational and work environments in the sciences and engineering and inherently put women at a disadvantage because women do not have other sources of information from which to draw support for the pursuit of a non-traditional career. Role models may, therefore, serve the important purpose of providing information.

Sources of Information Provided by Role Models

A number of researchers (e.g., Bell, 1970; Betz, 1994b; Betz & Fitzgerald, 1987) have suggested that role models serve the important function of providing information about how to do a task or how to overcome obstacles in one's career path. Almquist and Angrist (1971), on the other hand, make the interesting point that role models may sometimes go beyond providing simple "how-to" information and may provide other types of information, such as setting norms and values and providing recognition and reward for achievements. For women considering non-traditional careers, role models may serve the important functions of providing information about negotiating the demands associated with having a career and a family and providing information used in making self-efficacy evaluations.

Role model influence and perception of multiple roles. Women pursuing non-traditional careers may have concerns about combining a demanding job with family responsibilities, and role models who have successfully negotiated this difficult task may serve as an important source of information. Almquist and Angrist (1971) reported that female students who had high career salience were significantly more likely than women with low career salience to have had mothers who worked when they were young. When the researchers questioned the students about the impact of their mother's employment status on their own career choices, several reported having acquired a favorable definition of the working mother role by viewing their mothers' experiences. Working mothers as role models seemed to provide these women with the important information that combining marriage, family, and a career can be done, and that it can be enjoyable (Almquist & Angrist, 1971).

Additional support for the idea that role models may provide women with important information about life styles and handling multiple roles was provided in Gilbert's (1985) study of graduate students and their role models. Gilbert (1985) asked female and male graduate students to indicate factors or characteristics they had considered when selecting a mentor. Her results revealed that female students rated life-style and values as significantly more important in selecting their role model than did male students. Moreover, the women indicated they had attempted to select role models whose life styles seemed to be similar to their own life style aspirations. Gilbert (1985) concluded that female students, more than male students, tended to respond to models who were able effectively to integrate professional and personal roles, thereby supporting the idea that such information is critical in women's career development.

Role model influence and self-efficacy information. Another important source of information role models may provide is that which students use in establishing self-efficacy beliefs and expectations. Bandura (1977) discussed vicarious learning as an important source of self-efficacy information, and role models may be influential when their successes and failures are noted by others. Bandura (1986) pointed out that most college students have had little work experience in the career fields to which they aspire. In these situations, their efficacy evaluations would be particularly sensitive to vicarious information (Bandura, 1986). A student who has had no work experience in engineering, for example, may not know about her capability to handle the job requirements of a mechanical engineer. If she sees a young female professional engineer meeting her job responsibilities with success, however, she may incorporate the model's experiences into her beliefs about her own potential to do well in the field. On the other hand, if the student is aware of no female engineers, she may assume women are incapable of handling the necessary responsibilities.

Research has supported the idea of role models providing efficacy information to other people. Scherer, Brodzinski, and Wiebe (1991) found that individuals who had observed a model they perceived as a highly successful performer in a specific career or occupational field were more likely than those who had observed a model they perceived to be less successful in that field (a) to believe that they themselves would be successful in that field and (b) to express a preference for entering that career or field. Similarly, Little and Roach (1974) demonstrated that students who observed videotapes of role models successfully engaging in nontraditional occupations were more likely than those who did not view the videotapes to prefer nontraditional careers for themselves.

In summary, it seems clear that role models influence women's career behaviors and decisions in a number of ways. The underrepresentation of women in science and engineering fields may be partly due to the limited range of careers represented by female role models in the media and in the actual world of work.

Role Conflict

Another factor that may affect women's persistence in non-traditional fields, but that has received less research attention than many other constructs, is role conflict. As originally described by Kahn, Wolfe, Quinn, Snoek, and Rosenthal (1964), role conflict is the "simultaneous occurrence of two or more sets of pressures such that compliance with one would make more difficult compliance with the other" (p. 19). Combining occupational work and family life has become the norm and lifestyle preference for both men and women (Gilbert, 1994), and one common form of role conflict experienced by those who are full-time members of the labor force is that between work and family responsibilities. This type of conflict occurs when a person perceives that the role demands associated with work and family are incompatible or extremely difficult to combine successfully (Livingston & Burley, 1991). Because women have traditionally been responsible for home and family responsibilities, they may be more susceptible than men to experiencing role conflict if they choose to pursue a career (Betz, 1994b, Betz & Fitzgerald, 1987). In addition, a number of researchers (e.g., Arnold, 1993; Betz, 1994b; Betz & Fitzgerald, 1987; Olsen, Frieze, & Detlefsen, 1990; Seymour, 1995) have suggested women choose female-dominated professions in order to accommodate the multiple roles of worker, parent, and partner. Consequently, Lent et al. (1994) have called for including work/family conflict in models attempting to explain the developmental tasks that occur prior to, during, and after career entry. As discussed below, research evidence supports the idea that role conflict may help explain the underrepresentation of women in physical science, math, and engineering fields.

Gender Differences in Perceptions of Role Conflict

There appear to be gender differences in perceptions of conflict between the roles of worker and family member. Even before such conflict becomes a reality, gender differences in perceived difficulties with combining work and family roles in the future may be detected. In a 15-year longitudinal study of high school valedictorians, for example, Arnold (1993) found that female students expressed concern about expected future conflict between their work and family aspirations as early as during the second semester of their sophomore year in college. Male valedictorians in this study, on the other hand, did not express such concern. A study by Lips (1992), however, revealed conflicting results. Contrary to prediction, female college students in her study actually expressed less concern than males about the difficulties faced by women in combining careers in science or mathematics with marriage and motherhood. One possible explanation for the discrepant results may be the point at which students were asked about perceived conflict. The women in Lips' (1992) study were surveyed early in their freshman year of college, and it is possible that they had not yet fully considered what it would be like to combine work responsibilities with family responsibilities. This conflict may have been more salient for the women in Arnold's (1993) study because they would have had more time to consider both roles and may have felt more committed to their career roles because of their high degree of academic talent.

Regardless of their expectations prior to being involved in work and family, the majority of women and men eventually do report that both roles are important ones in their lives (Livingston & Burley, 1991). Results from studies involving employed mothers and fathers indicate that women experience substantially more actual conflict between work and family responsibilities than do men (Beutell & Greenhaus, 1982; Herman & Gyllstrom, 1977; Livingston & Burley, 1991). Reports of role conflict seem to increase as the number of children at home increases, and a general trend is that as a woman's participation in family activities expands, her personal and job frustrations become more pronounced (Bryson, Bryson, & Johnson, 1978). Whether such conflict is real or perceived, women's career decisions in various points over the life span may be significantly altered by difficulties in combining work and family responsibilities.

Role Conflict and Career Decision-Making Over the Life Span

Results of Arnold's (1993) valedictorian study suggest that women may start to be concerned about family-career conflict while they are in the early stages of career planning during the college years. During their sophomore year in college, these highly talented women showed anxiety about combining a career and a family. More compelling evidence that role conflict affects their career decisions, however, is illustrated by Arnold's (1993) finding that by their senior year of college, two-thirds of the women valedictorians planned to reduce or interrupt their future labor force participation in order to accommodate child raising. Expectations for late marriage and late childbearing during the college years were also indicative of career aspirations, with those planning to get married and have children earlier being much less likely to aspire to high levels of education and occupational status in their chosen career field (Arnold, 1993). Finally, in a ten-year follow-up study of the high school valedictorians, ACT scores and planned age at marriage were the best of a number of variables at predicting academic and occupational achievement (Arnold, 1993). Interestingly, this relationship was not affected by participants' actual age at marriage. There were no differences between high- and low-achieving women's actual age at marriage, suggesting that it is the anticipation of early marriage, and not actual age of marriage, that is critical in affecting women's career choices.

Role conflict may also affect the traditionality of career choices women make. In a review of several studies, Fassinger (1990) reported that the strongest predictor of career orientation and non-traditional career choice in several investigations of women's career development was marital and parental status, with marriage and motherhood generally being negatively related to a strong career orientation and non-traditional career choice (Fassinger, 1990). By surveying a sample of college women, McCracken and Weitzman (1997) found that commitment to having a lifestyle involving both a career and a family decreased as non-traditionality of career choice increased. In addition, Ware and Lee (1988) found that women who went to college and who valued their future homemaking role were less likely to major in science than in more traditional fields of study. Finally, when female students were asked about their perceptions of reasons for women's limited participation in science in studies conducted in 1964 and 1990, the reason most frequently cited (by 23.6% of respondents in 1964 and by 21.0% of respondents in 1990) was difficulty of managing demanding professional work with home and child responsibilities (Morgan, 1992).

Finally, for women in science and mathematics fields, concerns about combining family and work roles also affect persistence in those fields during the college years. Lips (1992) found that freshman female science and mathematics majors placed more importance than did male students on people-related concerns, such as combining a career and family. For women, belief in the compatibility of science or math career and family roles was positively related to intent to study more science. Somewhat surprising was that this relationship was only modest, and Lips (1992) suggested that as students get closer to choosing a career and get older, concerns about combing family/career roles might be expected to be more salient. Her study did, nevertheless, provide some evidence that women's relatively greater avoidance of mathematics and physical science courses may stem from conscious concern about the compatibility of math and science careers with women's family roles. A study by Seymour (1995) supported this idea; she found that 46% of the women in an undergraduate engineering major who subsequently switched to a nonscience major reported that they did so because the engineering major offered a lifestyle that was less appealing to them than the lifestyle offered by the new major.

Reasons for Difficulty Combining Non-Traditional Work with Family Responsibilities

Because women's perceptions of the difficulty involved in combining work and family roles seems to be greater for those pursuing non-traditional fields than for those pursuing traditional fields, a number of researchers have been interested in discovering what might make multiple role responsibilities particularly difficult in fields such as science and engineering. A number of possibilities have been proposed. One compelling reason is that, in some instances, female-dominated professions require less educational commitment than other types of careers, thereby allowing more time for family responsibilities (Murrell, Frieze, & Frost, 1991). This hypothesis is consistent with findings that have found lower educational aspirations for women who anticipate an early age for marriage and parenthood (Arnold, 1993). For college women who have strong self-efficacy expectations for balancing multiple roles, however, lower career aspirations are not necessarily the norm (Dukstein & O'Brien, 1995). Women in their study who believed they would be able to handle the responsibilities required of parent and worker often had career aspirations that were as high as women who did not place a great deal of importance on a future family role.

A second reason for particular difficulty combining non-traditional careers with family responsibilities may have to do with work schedules. Female-dominated occupations often allow for flexible hours, part-time work, and job sharing (Olsen et al., 1990; Post-Kammer & Smith, 1986), which are options not often permissible in male-dominated career fields. Morgan (1992) found that concern about an inability to work part-time in engineering was cited by 11% of female respondents in 1990 when asked to explain the underrepresentation of women in non-traditional fields.

Third, while salaries and promotions may be adversely affected when workers in male-dominated occupations leave and later re-enter the work force, this is less likely to be true for employees in female dominated fields (Baber & Monaghan, 1988; Olsen et al., 1990). Moreover, while a woman (or man) in other fields might be able to work part-time or take a year or two off to devote time to a family, this is more difficult in scientific fields because when one returns, the technology has become so much more advanced that he or she is no longer familiar with the state-of-the art information and techniques (Betz & Fitzgerald, 1987).

Thus, although relatively little research has investigated specific reasons for the difficulty in combining family and work responsibilities in the sciences and engineering, it appears that many women may select lower-paying, lower-status careers in traditionally-female fields because they believe the benefits associated with these careers would enable them to balance multiple career and family responsibilities (Dukstein & O'Brien, 1995). Lips (1992) suggested that most students probably do not make academic and career-related choices based solely on background and simultaneous forces, but they are probably also affected by anticipated future plans. Evidence suggests that students, at least by the college level, often choose courses and careers while also considering future family roles; they must ask themselves whether a certain career will accommodate their other needs and values, and science and engineering careers are more likely than careers in other fields to be seen as incompatible with family responsibilities (Ware & Lee, 1988; Widnall, 1988).

Research Documenting Relationships of the Variables to One Another

It is fairly clear that ability, self-efficacy, role model influence, and role conflict all play a role in women's career development in the sciences and engineering. What is less certain is how these relationships might be related to one another (Fassinger, 1985, 1990; Fitzgerald & Crites, 1980; Lent et al., 1994). Theoretical predictions and the limited amount of research that has attempted to explain how ability, self-efficacy, role model influence, and role conflict might be interrelated and how they affect career behavior are described below.

Relationship Between Ability and Self-Efficacy

Of the possible relationships among the four variables discussed in this review, the relationship that has been most firmly established is that between ability and self-efficacy. Theoretically, it has been suggested that there should be a relationship between these constructs, with higher ability being associated with higher self-efficacy (e.g., Bandura, 1977, 1986; Hackett & Betz, 1981). In general, it appears that there is indeed a moderate correlation between the two (Betz & Hackett, 1981; Hackett, 1985; Hackett & Betz, 1989; Lent et al., 1994, 1986). Hackett (1985) found a significant correlation between math self-efficacy scores and math ACT scores (r = .58), and she also found that math self-efficacy scores were significantly related to the number of math courses taken in high school. In another study, Hackett and Betz (1989) found a moderate correlation (r = .44) between performance on a math aptitude test and mathematics self-efficacy. Among a sample of engineering students, Schaefers et al. (1997) found positive relationships between math self-efficacy and first-semester grade point average (r = .32), cumulative grade point average (r = .36) and math ACT scores (r = .27). Finally, Lent et al. (1994) reported that the average correlation between ability and general academic self-efficacy across many studies was .38.

Relationship Between Role Model Influence and Role Conflict

The relationship between role model influence and role conflict has not been well tested. In fact, there has been very little research examining the interaction of role model influence with any other important influences of women's career development (Hackett et al., 1989). As described in more detail in the prior discussion of information provided by role models, a theoretical relationship between role model influence and role conflict seems plausible. Women who have access to role models who have successfully negotiated the demands associated with combining career and family relationships should, according to Bandura's (1986) social learning model, be more likely to believe that they themselves would be able to handle these two sets of demands.

Although this relationship has not yet been directly tested through research, Almquist and Angrist (1971) reported that women students whose mothers worked were more likely to have high career salience than women whose mothers did not work. Interview data suggested that these women believed their mothers had shown them that combining family and career responsibilities is possible and that it may be enjoyable (Almquist & Angrist, 1971). In another study, Gilbert (1985) found that female graduate students often selected role models who could effectively integrate professional and personal roles, suggesting that strategies for meeting the demands of work and a family is an important source of information graduate students may obtain from their mentors.

Because the relationship between role model influence and role conflict seems theoretically to be meaningful and because this relationship has not been empirically tested, research including both variables as predictors of women's career decisions and behavior is needed. The difficulty associated with combining technical/scientific careers with family responsibilities suggests this relationship may be particularly important in contributing to an understanding of the experiences of women in non-traditional fields.

Relationship Between Role Model Influence and Self-Efficacy

The relationship between role model influence and self-efficacy has also been hypothesized to exist (Bandura, 1977, 1986). Bandura's theory suggests that those who have seen a model successfully complete a task should vicariously learn from the model's experience and should be more likely than those who have seen a model fail at a task to assume that they themselves would be successful in completing the same task.

Some research has supported the hypothesis that role model influence and self-efficacy are positively related. It has been documented that students who observe a model performing successfully in a specific career or occupational field are more likely than students who observe a model performing unsuccessfully to believe that they themselves would be successful in that field. In addition, Little and Roach (1974) showed that students who watched videotapes of role models successfully engaging in nontraditional occupations were more likely than those who did not view the videotapes to prefer nontraditional careers for themselves.

No research to date has investigated the relationships between specific types of role model influence and self-efficacy for non-traditional careers, however. Investigating effects of both negative and positive role model influence, as well as investigating the influence of various types of role models on women's career decisions and persistence in non-traditional fields is needed.

Relationships Between Ability and Role Conflict and Between Ability and Role Model Influence

There have been no theoretical predictions and no prior research relating ability and role conflict. Likewise, there have been no hypotheses and no research examining the association between ability and role model influence. Intuitively, these relationships do not seem to be meaningful, and it does not seem that investigations of these sets of variables would add significantly to our understanding of women's career development.

Research Documenting the Variables' Influence on Career Aspirations

An outcome variable that has particular relevance for investigations of women's persistence in non-traditional fields is an assessment of career aspirations, which are the goals and plans a person hopes to reach within a given career field (Dukstein & O'Brien, 1995). Unfortunately, this construct has largely been overlooked in research investigating women's experiences in non-traditional fields. The majority of research has focused on young women's career development, exploring the effects of many factors on students' choice of a non-traditional college major versus a traditional college major or the effects of those factors on students' persistence in non-traditional college majors. Because women's participation in math, the physical sciences, and engineering drops dramatically at the doctoral level and in careers requiring advanced degrees, the U. S. Department of Labor (1994) identified doctoral productivity as the major barrier to women's achieving equity in science and engineering. As such, it is important for research to go beyond an exploration of persistence in undergraduate majors and to explore factors affecting women's plans and decisions to pursue graduate education and/or upper-level positions within the science and engineering work forces. The limited existing research that has investigated the effect of ability, self-efficacy, role model influence, or role conflict on career aspirations is reviewed below.

Relationship Between Ability and Career Aspirations

Previous research has suggested that the direct relationship between ability and career aspirations is a low, positive one. In their study of female college students in a variety of college majors, for example, Dukstein and O'Brien (1995) found that the correlation between college grade point average and career aspirations, as assessed by the Career Aspiration Scale (O'Brien, 1995), was .15 ($p < .05$). As described in prior sections, however, it is likely that the effects of ability on many career outcomes for women are mediated by self-efficacy expectations (Betz & Hackett, 1981).

Relationship Between Self-Efficacy and Career Aspirations

Although previous research has linked self-efficacy expectations to consideration of science and engineering careers (Betz & Hackett, 1983; Lent et al., 1986,1987), persistence in science courses (Deboer, 1984), persistence in science majors over a one-year period

(Lent et al., 1984), and grade goals (Wood & Locke, 1987), a search of existing research yielded no investigations of the direct effects of self-efficacy on career aspirations. Given the importance of this variable on other career outcomes, such research is clearly needed.

Relationship Between Role Model Influence and Career Aspirations

The influence of role models on career aspirations has been documented by Hackett et al. (1989), who found that contact with female teachers was positively related (r = .32) to educational and career aspirations in a sample of senior college women. Although very little research has been devoted to exploring through what avenues role models influence students, theoretical predictions have suggested that role model influence on career outcomes may be mediated by self-efficacy expectations (e.g., Bandura, 1977, 1986; Hackett & Betz, 1981) and information about managing the sometimes conflicting roles required of workers and family members (Gilbert, 1985). Empirical investigations of these theoretically meaningful relationships is needed.

Relationship Between Role Conflict and Career Aspirations

The relationship between role conflict and career aspirations has recently been investigated by Dukstein and O'Brien (1995). These researchers tested the effect of college women's beliefs about their ability to combine work and family responsibilities on their career aspirations, as measured by the Career Aspiration Scale (O'Brien, 1995). Their study revealed a low, positive correlation (r = .23) between confidence in the ability to handle multiple roles and career aspirations. This relationship might be expected to be higher in a sample of science and engineering participants, given students' perceptions of the difficulty in combining a science career with family responsibilities. In addition, Dukstein and O'Brien's (1995) study found age to be negatively correlated (r = -.20) with confidence in the ability to handle multiple roles, suggesting that women who have had more life experience expect, perhaps realistically, that combining the responsibilities of work and family will be difficult. These expectations, in turn, are inversely related to career aspirations.

Need for Unifying Theories

Research on women's career development has flourished in the past several decades, and tremendous strides have been made in identifying factors that affect the experiences of women in non-traditional fields. Less is known about the ways in which these factors may combine and interact with one another, and leaders in the field (e.g., Fassinger, 1985, 1990; Lent et al., 1994, Swanson & Tokar, 1991) have called for efforts designed to unify various theories and to find connections among seemingly diverse variables. The effects of ability, self-efficacy, role model influence, and role conflict on career aspirations have not yet been simultaneously investigated. Attempts to clarify these relationships was deemed necessary because of the particular relevance of this information for the career choices and behaviors of women in the physical sciences, math, and engineering.

Importance of Contrasting with the Experiences of Women in Biological Sciences

In addition to the lack of knowledge about how multiple variables work simultaneously to influence career aspirations, little is known about the ways in which the experiences of women in other science fields, such as the biological sciences, differ from those of women in the physical sciences, math, and engineering. Although both sets of occupations are non-traditional careers for women, gender stratification of the biological science educational and occupational forces is much less dramatic and in some cases is nearly non-existent; women make up nearly half of the students in some medical programs. No research to date has contrasted the experiences of women in the gender-balanced science fields with those of women in male-dominated fields. Investigating these differences was deemed appropriate because of the potential for shedding more light on the factors that uniquely affect the drastic underrepresentation of women in the physical sciences, math, and engineering.

CHAPTER 3

METHOD

Participants

Initial Pool of Participants

Participants in this study were female undergraduate students who were enrolled in mathematics, science, or engineering majors at Iowa State University (ISU). All female students who were classified as sophomores, juniors, or seniors in mathematics, physical science, and engineering majors (N = 468) were identified through a computerized sort of files from the Registrar's Office and selected for eligibility for participation in the study. Majors represented by students in this group included math, all types of engineering, computer science, statistics, biochemistry, geology, physics, and chemistry. In addition, a random sample of 307 female students classified as sophomores, juniors, or seniors in biological science majors (e.g., animal science, dietary science, agricultural studies, microbiology, botany, pre-veterinary medicine, biology, zoology, horticulture, pre-health professional studies, and genetics) at ISU were selected for participation. Thus, a total of 775 participants were selected to receive questionnaires. Freshmen were not included in the study because of the high likelihood that they would not be committed to their declared major during the first few months of the semester when the data were collected and, as a consequence, their responses may not have been typical of students who had actually selected math, science, and engineering majors.

Final Sample

The size of the final sample was determined by the number of students who agreed to participate by returning a questionnaire through the mail. Seven surveys from the math, physical science, and engineering group were returned undeliverable by the post office, and one survey from the biological science group was returned undeliverable; thus, the final response rates were based on the total number of delivered questionnaires (N = 461 for the mathematics, physical science, and engineering group; N = 306 for the biological science group). Three-hundred thirty-five students from the mathematics, physical science, and engineering group returned their surveys, representing a response rate of 73%. Two-hundred eleven participants from the biological sciences group returned surveys, representing a 69% response rate. The response rates for the mathematics, physical science, and engineering group and the biological science group were not significantly different, $\chi^2(1, N = 546) = 1.24$, $p > .10$. For the sample as a whole (N = 546), a 71% response rate was achieved.

In the final sample, the mean age of participants was 21.70 years (SD = 3.83). As shown in Table 1, students in the final sample represented a broad range of stages in their programs. A comparison between the two samples revealed a significant difference in the proportion of students across stages of programs, $\chi^2(3, N = 546) = 12.07$, $p = .01$, with women in the physical sciences, math, and engineering tending to be at more advanced levels than women in biological science majors in this sample. The mean number of credits earned by participants was 87.22 (SD = 34.98). Four-hundred-ninety-four (90.5%) of the participants identified themselves as Caucasian, 34 (6.2%) identified themselves as Asian Americans, 10 (1.8%) identified themselves as African Americans, 2 (.4%) identified themselves as Hispanic or Latino, 1 (.2%) identified herself as American Indian, and 5 (.9%) identified as "other."

In order to test the representativeness of the final sample of participants to the population of women in math, science, and engineering majors at Iowa State University, responders and non-responders to the survey were compared on year in school and on ethnicity. Chi-square analyses revealed that there were significant differences between participants and non-participants on year in school, $\chi^2(2, N = 775) = 18.86$, $p < .01$, such that a lower number of sophomores than expected participated in the study. This may suggest that a number of the second-year students changed majors or were planning to change majors prior to receiving the survey and self-selected out of the study. Participants and non-participants did not differ on ethnicity, $\chi^2(2, N = 775) = 1.04$, $p > .10$. Because of low cell sizes, categories of ethnicity for this analysis were collapsed into three groups: Caucasian students, Asian American students, and a third category combining all other ethnicities.

Measures

Because of the number of variables included in this model and because of the desire to reduce the amount of time required for students to complete the questionnaire, an attempt was made to minimize the number of items measuring any given variable. Thus, when existing valid and reliable measures were available, they usually were reduced to subscales of the instrument judged to be most relevant to the measured dimension; when no existing measures of a construct could be located, new items were generated for use in the study.

Table 1

Participants' Year in Program by Type of Program

	Type of Program		
Year in Program	Mathematics, Physical Science, and Engineering	Biological Science	Total Sample
Sophomore	53 (15.8%)	50 (23.7%)	103 (18.9%)
Junior	94 (28.1%)	72 (34.1%)	166 (30.4%)
Senior	102 (30.4%)	55 (26.1%)	157 (28.8%)
Fifth or beyond	86 (25.7%)	34 (16.1%)	120 (22.0%)

Note. Freshmen were not selected for participation in the study.

Demographics

Demographic information requested of students consisted of the questions listed in Appendix A. Students were asked to indicate their age, their year in school, the approximate number of college credits they had earned, their ethnicity, their major, the academic major in which they anticipate earning a bachelor's degree, the occupation they were pursuing, the highest level of education they planned to attain, their parents' and oldest sibling's highest level of education, their parents' occupations, their marital and parental status, and their plans for marriage and parenthood in the future.

Ability

Students' ACT or SAT quantitative, verbal, and composite scores and their cumulative college grade point averages were used as indicators of academic ability. This information was obtained, with students' permission, from their official University records. For the ACT and SAT scores, students' scores were transformed to z-scores by subtracting the national mean from the student's score and dividing by the national standard deviation. These scores were standardized in order to provide a common metric, given that some students only had ACT data and some students only had SAT data. A sizeable minority of students (n = 110) had taken both the SAT and the ACT; the z-scored values were averaged for these students. The resulting z-score reflecting either ACT, SAT, or combined scores was one indicator of the latent variable of Ability. The second indicator of Ability was cumulative grade point average. These measures are described in greater detail below.

ACT scores. The American College Test (ACT) consists of four components: English Usage, Mathematics Usage, Social Studies Reading, and National Sciences Reading. The composite score is made up of the average of a student's scores on those four subtests. Composite scores range from 1 to 35, and have a mean of 18.6 (SD = 6.0). The K-R 20 reliability coefficient based on a random sample of 2000 examinees from each national test date between 1984 and 1986 was .96 (ACT, 1988). Predictive validity has been demonstrated by showing that ACT scores correlate positively with subsequent college grade point averages. Using data from freshmen at 510 colleges, the American College Testing Program (ACT, 1988) reported that the median multiple correlation for predicting first-semester grade point average from the ACT was .48.

SAT scores. The Scholastic Aptitude Test (SAT) is a standardized, multiple-choice test that consists of a quantitative section and a verbal section. A composite score is made up of the average of a student's scores on those two subtests. Composite scores range from 200 to 800 and have a mean of 500 (SD = 100). The SAT has been shown to be reliable, and the predictive validity has been demonstrated by documenting that SAT scores are good predictors of freshman grade point average in college (Donlon, 1984). Based on a sample of 1,753 students who took the SAT in 1985, for example, Stricker (1991) found that the correlation between composite SAT scores and freshman-year GPA was .51.

Cumulative grade point average. The second indicator of ability was students' cumulative college grade point average. These grade point averages were calculated using a plus and minus system and were based on a four-point scale. These cumulative grade point averages were based on all of the students' college work prior to the academic semester in which the data were collected.

Self-Efficacy

Lent et al.'s (1986) Self-Efficacy for Academic Milestones Scale (AM-S) was used to measure self-efficacy. The original scale is composed of items 1-11 shown in Appendix B. This measure requires participants to rate their confidence, on a ten-point Likert scale (1 = "completely unsure" and 10 = "completely sure"), in their ability to perform specific accomplishments critical to success in most science and engineering majors (answering "no" to "Could you successfully complete this task?" results in a score of 1). In this study, 3 additional items (12-14 in Appendix B) were added to the scale because of anticipated ceiling effects for the more advanced students in the sample. Confidence ratings were summed across items and divided by 14 (the number of items on this scale) to obtain a strength of self-efficacy for academic milestones score for each participant. The possible range of scores was one to ten, with higher scores representing higher levels of self-efficacy.

The original measure has been shown to be reliable and valid. With a sample of science and engineering undergraduate students, Brown et al. (1989) reported adequate internal consistency reliability for the original 11-item scale (Cronbach's α = .89). The reliability of the new scale, comprising all 14 items, was α = .92, a slight increase over the reliability of the first 11 items alone (α = .90). In addition, Lent et al. (1986, 1987) have found AM-S scores to correlate positively with academic performance and persistence, range of perceived career options, and expressed vocational interests in scientific and engineering fields, thereby lending support to the validity of the measure.

In the present sample, each AM-S item was severely negatively skewed (mean skew = -1.91). In order to reduce the skew, each AM-S item was dichotomized as 0 or 1, with a score of 1 indicating that the student was "completely sure" of her ability to successfully complete that item, and a score of 0 indicating that the student was not "completely sure" of her ability to complete that item, regardless of how little or how much confidence she had.

An exploratory factor analysis using principal-axis factoring was conducted on the 14 dichotomized items. This procedure yielded a scree test suggesting that four factors should be extracted according to the eigenvalue-greater-than-1 criterion. The initial eigenvalues of these four factors, as well as the percent of variance explained by these four factors, were 6.17 (44.1%), 2.25 (16.1%), 1.42 (10.2%), and 1.12 (8.0%). After an oblique rotation (because of the theorized relationships among self-efficacy factors), this factor analysis suggested that four dimensions of self-efficacy existed (see Table 2 for the pattern matrix).

Table 2

Factor Loadings of Self-Efficacy for Academic Milestones Items (Oblique Rotation)

	Factor			
Item	Specific Classes	Completing Degree	Excelling in Field	Graduate School
AM-S 1	**.77**	.05	.03	-.06
AM-S 2	**.73**	.01	-.01	.07
AM-S 3	**.81**	-.06	.00	.03
AM-S 4	.24	**.52**	.06	.00
AM-S 5	.07	**.40**	.09	.23
AM-S 6	.01	**.86**	-.03	-.04
AM-S 7	-.06	**.99**	-.01	-.01
AM-S 8	-.06	**.91**	.02	.02
AM-S 9	.01	.00	**.92**	-.02
AM-S 10	-.01	-.01	**1.01**	-.02
AM-S 11	-.01	.01	**.94**	.03
AM-S 12	.02	-.01	.00	**.84**
AM-S 13	.00	.05	-.05	**.83**
AM-S 14	.01	-.05	.09	**.76**

Note. Items were dichotomized to reflect complete confidence (score of 1) versus less-than-complete confidence (score of 0); loadings presented in bold reflect the highest loading for each item.

These factors were named Specific Classes, Completing Degree, Excelling in the Field, and Graduate School. Curiously, after rotation the procedure converged with an improper solution. One factor loading (AM-S 10 loading on Excelling in the Field) was greater than 1.0, suggesting that extremely high correlations exist among the three Excelling-in-the-Field items (Bollen, 1989). The reliability of the scale of 14 dichotomized items was K-R 20 = .90. K-R 20 estimates for the four subscales composed of dichotomized items were as follows: Completing Degree (5 items) was .87 (N = 536), Excelling in Field (3 items) was .97 (N = 536), Graduate School (3 items) was .86 (N = 536), and Specific Classes (3 items) was .82 (N = 536). Correlations among the four factors are presented in Table 3.

Role Models

Influence of role model scale. Students were asked to complete the Influence of Role Model Scale (Basow & Howe, 1975), which involves rating a variety of people on the degree to which each has influenced the students' career choices (see Appendix C). The ratings are made on a seven-point scale (+1 to +3 represents a positive influence, 0 = a neutral influence, and -1 to -3 represents a negative influence). An overall influence of role models score was computed by summing students' responses to each of the items and dividing by the number of items rated as applicable to the respondent. The possible range of scores was -3 to +3, with higher scores representing more positive influence from role models. In order to ease computation by eliminating negative numbers, a value of 4 was added to each item. Thus, the possible range was from 1 to 7. The average score across these 14 items was used as one indicator of the latent variable positivity of role model influence.

Although this instrument has been used in several studies (e.g., Basow & Howe, 1979; 1980; Hackett, Esposito, & O'Halloran, 1989), very little information about the reliability and validity of the scale has been reported. The reliability (Cronbach's α) of the total scale in

Table 3

Correlations Among Self-Efficacy Factors (Oblique Rotation)

	1	2	3	4
1. Excelling in Field	1.00			
2. Completing Degree	.37	1.00		
3. Specific Classes	.47	.36	1.00	
4. Graduate School	.59	.32	.52	1.00

this study was .86. The scale does appear to have a high degree of face validity, and various items have been shown to be related to career salience, educational aspirations, non-traditionality of chosen major, science-relatedness of chosen major, and performance self-esteem (Hackett et al., 1989).

Additional role model influence questions. Students were also asked to respond to additional questions about the one person they believe to have been most influential in their decision to pursue a science or engineering career (see Appendix D). In addition to other information about this role model, students were asked to respond to three items indicating the extent to which this person had encouraged them in science, math, and engineering education and life in general. Students responded to these items on a 5-point Likert-type scale, with higher numbers indicating greater encouragement. The sum of these three items was used as a second indicator of positivity of role model influence. These items were written specifically for this study because a search of the literature yielded no existing measures designed to assess this information. As such, previous reliability and validity information were not available. The reliability for this three-item scale was α = .58, and the items have a high degree of face validity. Despite the relatively low reliability estimate, which is partially explained by the small number of items, all three items were retained in order to adequately measure the broad construct of role model influence.

Role Conflict

Seven items developed by Lips (1992) were used to assess students' beliefs in the compatibility of science careers with marriage and family responsibilities for women (see Appendix E). Each item requires respondents to rate, on a 5-point Likert-type scale (1 = strongly agree, 5 = strongly disagree), their agreement with statements reflecting attitudes about the possibility of women successfully combining career and family responsibilities. In computing a total score for this scale, items 4, 6, and 7 were reverse-scored and students' responses to the items summed and divided by 7 (the number of items on the scale). Thus, possible total scores ranged from 1 to 5, with higher scores representing more positive attitudes about the possibility of combining science career and family responsibilities. Lips (1992) reported a reliability coefficient of .75 for this set of items, and support for the items' validity was indicated by a positive relationship between scores on the scale and female students' selection of science academic and vocational goals. Cronbach's alpha for the seven items in this study was .81.

A principal axis factor analysis was conducted on the seven items. The scree test yielded only one factor with an eigenvalue greater than one, suggesting that the construct measured by these items is unidimensional. Nevertheless, the use of multiple indicators of a construct is preferable to the use of one indicator so that the error in measurement may be estimated. In order to create multiple indicators of this unidimensional construct, items on this scale were grouped into item parcels (see Marsh & Hocevar, 1985). These item parcels were created by conducting a factor analysis that forced all the items to load on one factor.

The items with the highest and lowest item-to-total correlations were paired, the items with the next highest and lowest loadings were paired, and the remaining three items were grouped into a third item parcel. This technique was designed to result in homogeneity with respect to item-to-scale correlation across the three indicators/parcels.

The factor analysis revealed a range of loadings from .49 to .79. Based on the pattern of loadings, items 3 and 4 were combined into one parcel, items 1 and 7 were combined into a second parcel, and items 2, 5, and 6 were combined to form the third parcel. The scores for these parcels were formed by averaging the scores on the items comprising them.

Career Aspirations

Career aspiration scale. The Career Aspiration Scale (CAS; O'Brien, 1995) was used to assess participants' science and engineering career aspirations. This ten-item scale (see Appendix F) assesses participants' career goals and plans within the occupation to which they aspire. Participants are asked to provide responses to the ten items by using a 5-point Likert-type scale (1 = "not at all true of me" to 5 = "very true of me"). A total score is obtained by summing the value of each item after four of the items (numbers 3, 4, 7, and 10) are reverse scored and dividing by 10 (the number of items on the scale). Thus, the possible range of scores is from 1 to 5, with higher scores being indicative of higher career aspirations within the students' chosen occupation.

O'Brien and Fassinger (1993) reported an internal consistency coefficient of .76 for this measure. The reliability estimate for the scale in this study, as indicated by Cronbach's alpha, was .80. The scale's validity was supported by positive correlations between scores on the CAS and measures of career salience, academic ability, number of semesters of math and science courses completed, and career self-efficacy (O'Brien, in press). Expected negative correlations were found between scores on the CAS and measures of both negative affectivity and occupational traditionality (O'Brien, in press).

A principal axis factor analysis was conducted on the ten items. The initial solution yielded two factors with eigenvalues greater than one (3.85 and 1.34). However, separate factor analyses specifying two and three factors with varimax and oblique rotations failed to converge with interpretable factor structures. Therefore, although the CAS does appear to measure multiple dimensions of career aspirations, the CAS was treated as a unidimensional construct in the present study. As such, the same method described for creating the three indicators of role conflict (see previous subsection) was used for the CAS. The factor analysis, forcing all items to load on one factor, yielded a range of loadings from .35 to .75. Based on the rank order of loadings, items 1, 3, 4, and 9 were averaged to form the first indicator/parcel, items 2, 5, and 10 were averaged to form the second indicator/parcel, and items 6, 7, and 8 were averaged to form the third indicator/parcel.

Anticipated level of education. The highest level of education participants planned to obtain was used as a fourth indicator of career aspirations. This variable was assessed by a single item asking participants to indicate the highest level of education they anticipated completing in their lifetime. This variable was coded such that students received a score of 1 if the highest level of education they planned to obtain was a bachelor's degree, a score of 2 if the highest level of education they planned to obtain was a master's degree, and a score of 3 if the highest level of education they planned to obtain was a doctoral degree, medical degree, or law degree.

Procedure

This study was conducted in accordance with the ethical principles of the American Psychological Association, and the proposed methodology was reviewed and approved by the Human Subjects Committee at Iowa State University. The Iowa State University

Registrar's Office provided names and local addresses for all students who met the selection criteria. Students were mailed a questionnaire packet that included a letter of solicitation (see Appendix G), a consent form (see Appendix H), a questionnaire (consisting of the measures in Appendices A - F), and a return envelope. To thank students for their participation and to increase the response rate, students were informed that by returning their questionnaire they would be eligible to win one of three $100 prizes which would be awarded to randomly selected participants who returned their questionnaire by October 31, 1996. Ten days after the questionnaires were sent to students, reminder postcards (see Appendix I) were mailed to those students who had not responded. Finally, two weeks later, follow-up letters (see Appendix J) and new questionnaires were sent to those students who still had not responded to the postcard reminder.

CHAPTER 4

RESULTS

Chapter 4 is composed of two sections. The first section reports overall means and frequencies of the variables in the study, including descriptions of differences in means and frequencies between students in mathematics, physical science, and engineering majors and students in biological science majors. The second section describes the latent variable modeling procedure. An explanation of the measurement model and the structural model results are presented in the second section.

Means, Frequencies, and Group Differences

In order to examine mean differences as a result of students' type of program, a series of t-tests and chi-square tests was performed. Because these comparisons were exploratory in nature, a Bonferroni adjustment was used for each group of analyses (by dividing the traditional .05 alpha level by the number of comparisons) in order to avoid capitalizing on Type 1 error (Keppel, 1982).

Demographics

Six chi-square tests and three t-tests were conducted on a variety of demographic variables. Accordingly, an adjusted alpha level of .006 was used. The chi-square tests failed to reveal differences between women in mathematics, physical science, and engineering majors and women in biological science majors on the following variables: father's highest education, $\chi^2(3, N = 544) = 4.17$, $p = .24$; mother's highest education, $\chi^2(3, N = 543) = 5.18$, $p = .16$; sibling's highest education, $\chi^2(3, N = 464) = .04$, $p = .99$. Table 4 shows the frequencies of these variables. Also note that father's, mother's, and sibling's highest level of education were collapsed into four categories in order to meet the minimum expected cell frequencies for the chi-square tests.

Table 4

Father's, Mother's, and Sibling's Highest Education

	Math, Physical Sciences, and Engineering		Biological Sciences		Total	
	n	%	n	%	N	%
Father's Highest Education						
High School or Less	104	31%	76	36%	180	33%
Technical or Vocational School	47	14%	37	18%	84	15%
Bachelor's Degree	111	33%	62	30%	173	32%
Graduate Degree	72	22%	35	17%	107	20%
Total	334	100%	210	100%	544	100%
Mother's Highest Education						
High School or Less	110	33%	76	36%	186	34%
Technical or Vocational School	62	19%	50	24%	112	21%
Bachelor's Degree	104	31%	58	28%	162	30%
Graduate Degree	58	17%	25	12%	83	15%
Total	334	100%	209	100%	543	100%
Sibling's Highest Education						
High School or Less	123	37%	80	44%	203	44%
Technical or Vocational School	31	11%	19	10%	50	11%
Bachelor's Degree	97	34%	62	34%	159	34%
Graduate Degree	32	11%	20	11%	52	11%
Total	283	100%	181	100%	464	100%

Note. Sibling refers to sibling with the highest level of education.

In addition to family members' levels of education, no differences were found between the samples on the following variables: participant's marital status, $\chi^2(1, \underline{N} = 545) = .02$, $\underline{p} = .90$; participant's plans to marry, $\chi^2(1, \underline{N} = 485) = .62$, $\underline{p} = .43$; and whether the participant currently had children, $\chi^2(1, \underline{N} = 539) = 3.24$, $\underline{p} = .07$. Only 4% of the total sample reported having children. Ten percent of the entire sample reported being married, whereas 96% of the sample reported planning to marry at some point.

Three t-tests were used to check for differences between the two groups of participants on the three continuous demographic variables. No differences were found between these two groups on anticipated age of marriage, $\underline{t}(437) = 1.35$, $\underline{p} = .18$, ($\underline{M} = 25.29$, $\underline{SD} = 3.00$, $\underline{N} = 439$ for entire sample) and on the number of children they anticipate having, $\underline{t}(472) = 1.06$, $\underline{p} = .29$, ($\underline{M} = 2.51$, $\underline{SD} = .90$, $\underline{N} = 474$ for entire sample). However, there was a difference in the age at which participants anticipated having their first child, $\underline{t}(465) = 2.80$, $\underline{p} = .005$. Women in the mathematics, physical science, and engineering group anticipated having their first child at an older age ($\underline{M} = 28.30$, $\underline{SD} = 2.77$, $\underline{n} = 489$) than did those in the biological sciences group ($\underline{M} = 27.59$, $\underline{SD} = 2.51$, $\underline{n} = 178$). The average age at which participants anticipated having their first child across both samples was 28.03 ($\underline{SD} = 2.69$, $\underline{N} = 467$).

Ability

A t-test was conducted on a weighted composite of GPA and ACT/SAT scores to examine differences between the two groups. The weights for GPA and ACT/SAT were derived from the factor loadings obtained from the measurement model described later on page 72. This analysis was significant, $\underline{t}(508) = 2.97$, $\underline{p} = .003$, with students in the physical sciences, mathematics, and engineering scoring higher on the weighted composite than students in the biological sciences. Two follow-up t-tests were then conducted on the two ability measures. A Bonferroni adjustment was used to reduce the significance level to .025.

The two groups of women differed on ACT/SAT scores, $t(508) = 4.22$, $p < .001$, such that women in math, physical science, and engineering had higher standardized test scores (M = 1.27, SD = 0.65, n = 316) than did women in the biological sciences (M = 1.03, SD 0.56, n = 194). The two groups did not differ in cumulative GPA, $t(509) = 1.17$, $p > .05$; women in math, physical science, or engineering had GPAs (M = 3.02, SD = 0.53, n = 316) that were similar to those of women in the biological sciences (M = 2.96, SD = 0.59, n = 195).

Self-Efficacy

In order to test for differences between the two groups on self-efficacy, a t-test was conducted on a weighted composite of self-efficacy scores (one score representing each AM-S factor). This t-test was significant, $t(499) = 5.40$, $p < .001$, with students in the physical sciences, mathematics, and engineering group scoring higher on the weighted composite than students in the biological sciences. As a follow-up to this analysis, four separate t-tests (with adjusted alpha levels of .0125) were conducted on the AM-S factors. Women in the math, physical science, and engineering majors scored higher on three of the four factors of the self-efficacy measure: Excelling in the Field, Graduate School, and Specific Classes. Table 5 illustrates mean differences and test statistics for these t-tests.

Positivity of Role Model Influence

In order to explore differences in the positivity of role model influence between the two groups, a combination of descriptive statistics and the results of hypothesis tests are presented in this section. First, a frequency count of the one person the participant indicated has had the most positive influence on her decision to pursue a career in science, mathematics, or engineering was calculated. For each group, fathers were indicated as the one person who had the most positive influence on this decision (for physical science majors, 35% indicated their father as most influential; for biological sciences, 27% indicated their father as most influential). This was followed by their mother (18% for physical science

Table 5

Differences Between Samples on AM-S Factors

	Math, Physical Science, and Engineering			Biological Science					
Factor	M	SD	n	M	SD	n	t	df	p
Completing Degree	.74	.33	334	.68	.38	210	1.90	400	.058
Excelling in the Field	.32	.45	334	.22	.40	209	2.60	480	.010
Graduate School	.23	.38	334	.14	.29	210	3.15	517	.002
Specific Classes	.47	.42	335	.19	.33	211	8.92	518	.001

Note. Means refer to average response to dichotomous items (1 = complete confidence in ability to complete the task, 0 = less-than-complete confidence in ability to complete the task).

majors, 21% for biological science majors) and male math, science, and engineering teachers (14% for physical science majors, and 10% for biological science majors).

A t-test was conducted on the weighted composite of scores on (a) the sum of the three role model encouragement items and (b) the total score on the Role Model Influence Scale. The t-test was significant, $t(530) = 2.56$, $p = .011$, with women in the biological sciences scoring higher on the weighted composite than women in the physical sciences, mathematics, and engineering. Two follow-up t-tests, with the reduced alpha level of .003 (because of additional tests that follow), were conducted. The groups did not differ on the sum of items reflecting role model encouragement, $t(483) = 0.21$, $p = .83$, nor did they differ on total scores on the Role Model Influence Scale, $t(543) = 1.29$, $p = .20$.

Thirteen additional t-tests were conducted to examine differences between the two groups on various role model items. Because these analyses were preceded by two other tests (described in the previous paragraph), an adjusted alpha level of .003 was used. The first t-test was conducted to examine differences between the two groups in the participant's perception of the role model's success at combining marriage and family responsibilities. This analysis was non-significant at the reduced alpha level, $t(531) = 2.31$, $p = .022$. The remaining 12 t-tests were conducted to check for differences between the two groups on the number of each of several types of male and female role models known. Table 6 illustrates these differences. As indicated in the table, women in mathematics, physical science, and engineering majors reported knowing more female engineering teachers, more female engineers, more male math teachers, more male engineering teachers, and more male engineers than did women in the biological sciences.

Role Conflict

In order to test for differences between the two groups on role conflict, a t-test was conducted on the weighted composite of scores on the three item parcels reflecting students' beliefs in the compatibility of marriage and family responsibilities with science careers. This t-test was not significant, $t(544) = .38$, $p = .706$, suggesting that they did not differ in terms of the extent to which they perceive science careers to be compatible with marriage and family responsibilities.

Career Aspirations

A chi-square test and a t-test were used to examine differences in career aspirations between the two groups. Accordingly the alpha level was reduced to .025. The chi-square analysis was used to test for differences between the two groups on the highest level of education they plan to obtain. The chi-square test was significant, $\chi^2(2, N = 546) = 47.19$,

Table 6

Differences Between Samples on Number of Role Models Known

	Math, Physical Science, and Engineering			Biological Science					
Factor	M	SD	n	M	SD	n	t	df	p
Female math teachers	1.86	1.76	333	1.49	1.51	207	2.49	538	.013
Female science teachers	1.64	1.99	333	1.84	1.80	207	1.20	538	.23
Female engineering teachers	0.71	0.91	333	0.01	0.16	207	13.68	363	.001*
Female mathematicians	0.49	2.82	333	0.29	0.70	207	1.04	538	.30
Female scientists	1.34	3.54	333	1.83	3.11	207	1.64	538	.10
Female engineers	2.49	4.70	333	0.56	1.46	207	6.95	427	.001*
Male math teachers	4.99	3.90	333	2.98	2.35	207	7.46	537	.001*
Male science teachers	5.29	4.61	334	4.97	4.49	207	0.80	539	.43
Male engineering teachers	6.14	8.05	334	0.26	1.09	207	13.15	353	.001*
Male mathematicians	1.55	3.47	333	0.86	2.03	206	2.93	536	.004
Male scientists	2.95	4.95	333	3.33	4.44	207	0.91	538	.36
Male engineers	8.37	10.63	333	1.74	3.21	207	10.62	422	.001*

Note. Means refer to average response to dichotomous items. * = significant at the adjusted .003 alpha level.

Table 7

Highest Level of Education Anticipated by Type of Program

	Type of Program		
Year in Program	Mathematics, Physical Science, and Engineering	Biological Science	Total Sample
Bachelors Degree	114 (34.4%)	66 (31.6%)	180 (33.3%)
Masters Degree	156 (47.1%)	51 (24.4%)	207 (38.3%)
Doctoral or Professional Degree	61 (18.4%)	92 (44.0%)	153 (28.3%)

Note. Levels of education were collapsed for this analysis in order to meet the minimum expected cell frequencies.

$p < .001$. Table 7 illustrates the frequencies and percentages of students in each group anticipating completing various levels of education. The largest contribution to the significant chi-square was the larger-than-expected number of women in the biological sciences anticipating obtaining a doctoral or professional degree.

The t-test was used to examine differences between the two groups on a weighted composite of scores on the three item parcels of the Career Aspiration Scale. This t-test was not significant at the reduced alpha level, $t(420) = 1.65$, $p = .10$. Thus, although the two groups differed on the highest educational level they planned to obtain, they were not different on overall career aspirations.

Test of the Hypothesized Model

Structural equation modeling with latent variables was used to test the hypothesized model via the EQS 5.4 (Bentler & Wu, 1993) program's maximum likelihood procedure.

Structural equation modeling was employed because using latent variables as opposed to observed variables in model testing allows for the removal of random measurement error; this is desirable since such error often attenuates the path coefficients in ordinary least squares regression.

Goodness-of-Fit Indicators

The EQS program simultaneously estimates the measurement and structural components of a model based on the variances and covariances of the observed variables, yielding a goodness of fit index of the model to the data. For this study, three indices of fit are reported. The chi-square statistic, although not a good measure of overall model fit, was reported as a test of the difference in fit between the measurement and structural models. Because the chi-square value estimated by the normal theory maximum likelihood (ML) procedure can be easily compromised given violations of the assumption of multivariate normality among the data, the Satorra-Bentler Rescaled χ^2 (SB χ^2; Satorra & Bentler, 1988) was reported in place of the more traditional ML χ^2. This was necessary because data from the present study were not multivariate normal (normalized multivariate kurtosis = 2.56, $p <$ .05.) Whereas the ML χ^2 is often inflated in the presence of multivariate skew and kurtosis, the SB χ^2 has been shown to be unbiased among nonnormal data at a wide range of sample sizes (Curran, West, & Finch, 1996). It should also be noted that standard errors of the parameter estimates may also be inflated when data are nonnormal; as such, robust estimates of the standard errors were used in all significance tests of parameters in the present study.

Two indices were reported as measures of overall model fit. The Comparative Fit Index (CFI) reflects the difference in fit between a theoretical model and a model specifying independence among variables, and it is believed to be relatively unaffected by sample size (Bentler, 1990). The Goodness of Fit Index (GFI) represents the proportion of variances and covariances in the data explained by a theoretical model; in other words, the GFI is a multivariate extension of the $\underline{R}^2$. The CFI and GFI may range from zero to one, with indices of .90 or higher considered to provide a good fit of the model to data.

Fit of the Measurement Model

Multiple indicators were used for five of the six constructs in the model (see Figure 2). The latent constructs and their measured indicators were as follows: Ability was measured by SAT/ACT and GPA; self-efficacy was measured by the factors Completing Degree, Excelling in the Field, Graduate School, and Specific Classes; positivity of role models was measured by the IRMS and the three positivity of influence items; role conflict was measured by the three item parcels of the Role Conflict Scale; and career aspirations was measured by the three item parcels plus the highest degree the participant planned to attain. Year in program was a single-indicator variable.

The first step in testing the fit of the model was to assess the fit of the indicator variables to their latent factors (Bollen, 1989). This was, in essence, a confirmatory factor analysis, such that the factor structure indicated in Figure 2 was tested. The factor loading of year in program was fixed to 1 and its error term was fixed to 0 (i.e., suggesting perfect measurement); all other factor loadings of indicators to their respective construct were freely estimated. Moreover, all correlations among the latent constructs were freed, thereby allowing all relationships among the constructs to be estimated as part of the measurement model. As such, the measurement model should only have deviated from the true nature of the data to the extent that the constructs were imprecisely measured.

A variance-covariance matrix with 16 measured variables was used as input data for the measurement model. The EQS program suggested that the model provided a good fit to the data, SB $\chi^2(90, \underline{N} = 489) = 296.37$, GFI = .93, CFI = .91. However, an examination of the factor loadings for this measurement model revealed that the factor loading for the highest

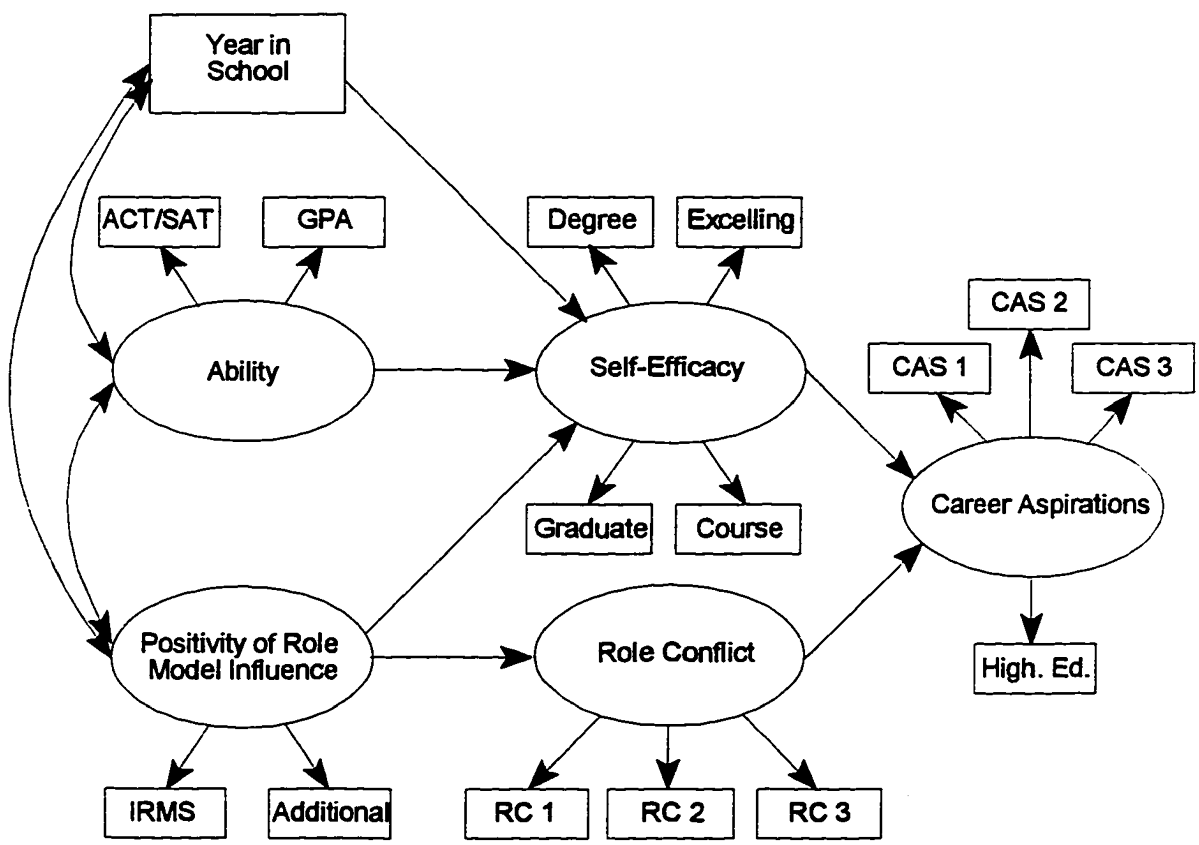

Figure 2. Specification of measured indicators to latent constructs (hypothesized parameters indicated).

level of education participants were planning to attain was .42, whereas factor loadings for the other three indicators of career aspirations were .64, .81, and .86, suggesting that the highest degree these women were planning to attain was not measuring the construct of career aspirations very well. In order to improve the measurement of the constructs, as well as the overall fit of the model, this indicator was not used in the subsequent modeling analyses.

A new variance-covariance matrix with 15 measured variables was used as input data for a new measurement model (this one with only three indicators of career aspirations.) The EQS program suggested that the fit of the model was good, SB $\chi^2(76, N = 495) = 200.82$, GFI = .95, CFI = .94. The correlations among the latent constructs in the measurement model are presented in Table 8. Factor loadings of the indicators on their respective latent constructs are presented in Table 9. The 15-variable variance-covariance matrix is presented as Table 10.

Table 8

Correlations Among Latent Factors in Measurement Model (Both Groups)

Construct	1	2	3	4	5
1. Year in school					
2. Ability	-.07				
3. Positivity of Role Model Influence	-.07	.05			
4. Self-Efficacy	.21*	.46*	.29*		
5. Role Conflict	-.02	.09	-.42*	-.11	
6. Career Aspirations	.11*	.09	.46*	.31*	-.31*

Note. *$p < .05$, $N = 495$.

Table 9

Standardized Factor Loadings for Measurement Model (Both Groups)

Measure	Factor Loading
Year in School	1.00
Ability	
ACT/SAT	.67
GPA	.79
Positivity of Role Model Influence	
Influence of Role Model Scale	.61
Sum of Additional Role Model Items	.58
Self-Efficacy	
Completing Degree	.58
Excelling in the Field	.73
Succeeding in Graduate School	.70
Completing Course Requirements	.66
Role Conflict	
Role Conflict 1	.76
Role Conflict 2	.77
Role Conflict 3	.80
Career Aspirations	
Career Aspirations Scale 1	.85
Career Aspirations Scale 2	.66
Career Aspirations Scale 3	.81

Note. All factor loadings significant, $p < .05$.

Table 10

Covariance Matrix for Both Groups

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Yr School	1.064														
2.	ACT/SAT	-0.062	0.393													
3.	GPA	-0.012	0.186	0.311												
4.	IRMS	-0.008	-0.032	0.025	0.556											
5.	Additional	-0.059	-0.012	0.031	0.213	0.641										
6.	SE-Degree	0.070	0.042	0.037	0.042	0.028	0.125									
7.	SE-Excel	0.067	0.044	0.082	0.032	0.041	0.064	0.193								
8.	SE-Grad	0.022	0.031	0.043	0.042	0.041	0.047	0.084	0.122							
9.	SE-Classes	0.077	0.079	0.053	0.017	0.027	0.057	0.080	0.066	0.168						
10.	Role Con 1	0.010	-0.004	0.005	-0.165	-0.119	-0.054	-0.012	-0.033	-0.020	0.740					
11.	Role Con 2	-0.021	0.052	0.024	-0.172	-0.108	-0.032	-0.007	-0.035	-0.021	0.440	0.781				
12.	Role Con 3	-0.021	0.027	0.045	-0.120	-0.068	-0.031	0.001	-0.009	0.004	0.402	0.416	0.587			
13.	CAS 1	0.030	0.026	0.044	0.086	0.155	0.039	0.042	0.054	0.067	-0.128	-0.099	-0.105	0.548		
14.	CAS 2	0.140	-0.043	0.002	0.162	0.128	0.031	0.028	0.037	0.052	-0.134	-0.125	-0.140	0.350	0.682	
15.	CAS 3	0.077	-0.003	0.034	0.112	0.135	0.036	0.051	0.058	0.055	-0.132	-0.110	-0.103	0.349	0.288	0.463
Mean		3.519	1.180	2.992	5.622	3.942	0.716	0.284	0.197	0.363	1.909	2.230	1.828	3.599	3.822	4.096
Std Dev		1.032	0.627	0.558	0.746	0.801	0.354	0.439	0.349	0.410	0.860	0.884	0.766	0.740	0.826	0.681

Note. $N = 495$.

Fit of the Structural Model

The hypothesized model presented in Figure 1 (p. 9) was tested by the EQS 5.4 maximum-likelihood procedure using the covariance matrix presented in Table 10 as input. This model provided a good overall fit to the data, SB $\chi^2(82, N = 495) = 223.52$, GFI = .94, CFI = .93 (see Figure 3 for path estimates). However, the fit of the structural model significantly departed from the fit of the measurement model, $\Delta\chi^2(6) = 22.70$, $p < .01$, suggesting that the structural model does not completely explain the relations among the constructs. This is likely because there were some paths fixed to zero that perhaps would have been significant if they had been estimated. A test of a modified model that included one or more of these paths would have been possible but was deemed inappropriate because of problems with inflation of Type 1 error (Keppel, 1982) and because of sample specificity problems.

As indicated in Figure 3, all hypothesized path coefficients were significant and in the predicted direction. Self-efficacy was significantly predicted by year in school, ability, and positivity of role model influence, such that higher values of these predictors were associated with greater self-efficacy. These three constructs explained over one-third of the variance in self-efficacy ($R^2 = .35$). Role conflict was significantly predicted by positivity of role model influence ($R^2 = .19$); more positive role model influences were associated with lower role conflict. Finally, career aspirations were significantly predicted by self-efficacy and role conflict ($R^2 = .19$). A greater sense of self-efficacy and lower perceived conflict between family and work responsibilities were associated with higher career aspirations within the student's field.

In addition to the significant direct relationships, several indirect relationships were significant at the .05 alpha level. Year in program had a significant, indirect association with career aspirations, $r = .08$, as mediated by self-efficacy. Ability also had a significant, indirect

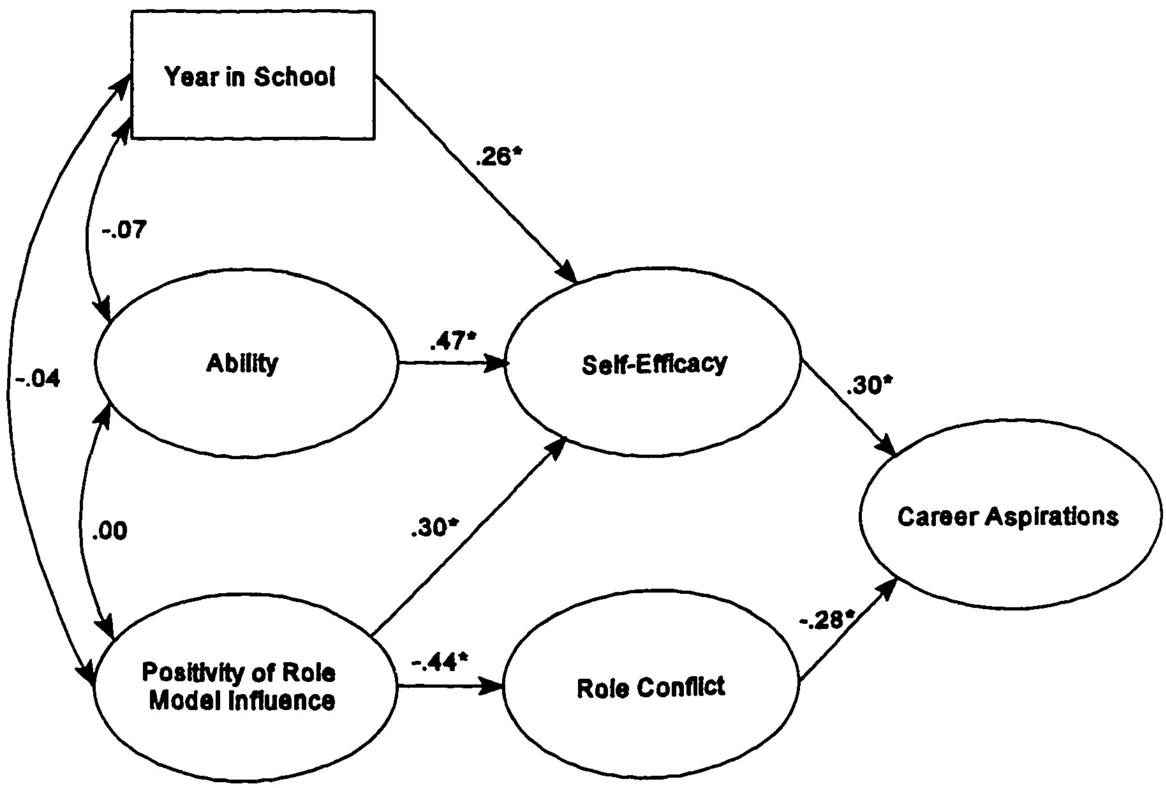

Figure 3. Parameter estimates for hypothesized structural model. * = significant at .05 level.

relationship with career aspirations, r = .14, also mediated by self-efficacy. Finally, the indirect relationship between positivity of role model influence and career aspirations was significant, r = .21. This relationship was mediated by both self-efficacy and by role conflict.

Comparison of Model Fit Between Two Samples

Despite the good fit of the theoretical model to the data from women in both biological sciences and in mathematics, physical science, and engineering, a central research question was whether the structural components of the model fit equally well for the two different groups. In order to compare the parameter estimates for the model based on students in mathematics, physical sciences, and engineering with students in biological sciences, a multiple-groups analysis was conducted. This analysis allows one to assess whether the structural paths in the two models differ. In the present study, a multiple-groups analysis was conducted to assess whether the six structural paths illustrated in Figure 3 differed between the two samples. This analysis required the use of a separate variance-covariance matrix for each sample (see Tables 11 and 12).

Bollen (1989) described a hierarchy of constraints when comparing two or more groups, ranging from models only being similar in form to models in which all parameters are constrained to be equal. In the present study, the research question concerned the equality of the six structural paths; thus, two multiple-groups models were tested. In the first model, the values of the structural paths were allowed to vary. In the second model, the six pairs of structural paths were constrained to be equal. In each model, factor loadings between the two groups were held invariant so as to assure that the constructs were being measured similarly between groups. If the χ^2 value obtained from the model in which the paths are allowed to vary is significantly lower than the χ^2 value obtained from the model in which paths are held invariant, then one may conclude that the former model provides a better fit to

Table 11

Covariance Matrix for Mathematics, Physical Sciences, and Engineering Group

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Yr School	1.063														
2. ACT/SAT	-0.062	0.423													
3. GPA	-0.009	0.187	0.284												
4. IRMS	0.019	-0.025	-0.005	0.535											
5. Additional	-0.031	-0.038	-0.017	0.178	0.611										
6. SE-Degree	0.071	0.038	0.040	0.040	0.024	0.111									
7. SE-Excel	0.094	0.040	0.092	0.045	0.049	0.066	0.208								
8. SE-Grad	0.025	0.033	0.055	0.048	0.047	0.050	0.097	0.137							
9. SE-Classes	0.082	0.071	0.062	0.034	0.042	0.063	0.090	0.071	0.175						
10. Role Con 1	0.033	0.036	0.045	-0.152	-0.114	-0.036	0.006	-0.031	-0.006	0.767					
11. Role Con 2	0.011	0.086	0.037	-0.174	-0.088	-0.028	-0.019	-0.041	-0.013	0.501	0.839				
12. Role Con 3	-0.016	0.062	0.067	-0.105	-0.036	-0.018	0.005	-0.010	0.011	0.427	0.438	0.595			
13. CAS 1	0.033	0.035	0.044	0.037	0.122	0.044	0.049	0.059	0.075	-0.104	-0.103	-0.086	0.520		
14. CAS 2	0.160	-0.038	-0.017	0.120	0.120	0.047	0.049	0.044	0.065	-0.148	-0.160	-0.160	0.310	0.637	
15. CAS 3	0.099	0.000	0.038	0.093	0.109	0.039	0.067	0.063	0.071	-0.121	-0.123	-0.110	0.332	0.271	0.454
Mean	3.632	1.267	3.011	5.585	3.860	0.738	0.322	0.224	0.466	1.922	2.238	1.865	3.636	3.868	4.103
Std Dev	1.031	0.650	0.533	0.731	0.782	0.334	0.456	0.371	0.419	0.876	0.916	0.771	0.721	0.798	0.674

Note. n = 307.

Table 12

Covariance Matrix for Biological Sciences Group

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Yr School	1.015														
2. ACT/SAT	-0.107	0.312													
3. GPA	-0.027	0.179	0.356												
4. IRMS	-0.033	-0.030	0.078	0.588											
5. Additional	-0.066	0.062	0.116	0.258	0.666										
6. SE-Degree	0.059	0.039	0.031	0.049	0.043	0.146									
7. SE-Excel	0.004	0.037	0.063	0.017	0.042	0.059	0.163								
8. SE-Grad	0.006	0.017	0.021	0.036	0.043	0.039	0.060	0.094							
9. SE-Classes	0.018	0.054	0.030	0.005	0.038	0.038	0.049	0.046	0.112						
10. Role Con 1	-0.035	-0.075	-0.062	-0.183	-0.124	-0.086	-0.043	-0.037	-0.049	0.699					
11. Role Con 2	-0.076	-0.007	0.001	-0.169	-0.137	-0.040	0.011	-0.026	-0.037	0.340	0.690				
12. Role Con 3	-0.048	-0.043	0.008	-0.140	-0.107	-0.056	-0.011	-0.011	-0.025	0.361	0.382	0.571			
13. CAS 1	0.007	-0.003	0.043	0.173	0.222	0.028	0.025	0.041	0.036	-0.170	-0.095	-0.144	0.590		
14. CAS 2	0.085	-0.067	0.028	0.240	0.160	0.000	-0.013	0.019	0.011	-0.114	-0.068	-0.117	0.410	0.752	
15. CAS 3	0.039	-0.009	0.028	0.145	0.181	0.030	0.023	0.051	0.027	-0.151	-0.088	-0.094	0.378	0.316	0.480
Mean	3.335	1.036	2.961	5.682	4.075	0.680	0.222	0.152	0.195	1.888	2.218	1.767	3.538	3.746	4.085
Std Dev	1.008	0.559	0.597	0.767	0.816	0.382	0.403	0.307	0.334	0.836	0.831	0.755	0.768	0.867	0.693

Note. n = 188.

the data. Such a finding would argue that the structural paths do indeed differ between the two groups.

The test of the model in which paths were allowed to vary revealed that the model provided a good fit to the data, χ^2 (173, N = 495) = 299.94, CFI = .94, GFI = .93. The test of the model in which paths were constrained to be equal also provided a good fit to the data, χ^2 (179, N = 495) = 314.13, CFI = .93, GFI = .92. However, the difference in fit between these two models was significant, $\Delta\chi^2$ (6) = 14.19, $p < .05$, suggesting that the structural paths do indeed differ between the two groups of students.

A series of six follow-up chi-square difference tests was used to examine which pair or pairs of path estimates were significantly different from one another. This was done by comparing the more restrictive model (the model specifying invariant structural paths) with six different models, each allowing only one of the structural paths to vary. A significant chi-square value for a given model would indicate that the structural path allowed to vary in that model is significantly different between samples. It should be noted that this examination was of a post hoc nature; as such, these findings are in need of replication because of sample specificity problems. It should also be noted that these post hoc analyses did not test whether any nonspecified paths would have been significant (if specified) in one group but not the other. Rather, these tests only assessed whether any of the six specified paths differed between the two groups.

The series of chi-square difference tests suggested that the paths between ability and self-efficacy, $\Delta\chi^2$ (1) = 5.67, $p < .05$, and between positivity of role model influence and self-efficacy, $\Delta\chi^2$ (6) = 4.90, $p < .05$, each varied between groups. A model in which both of these paths were allowed to vary between groups reflected a significant improvement in model fit over the model in which all six paths were held invariant, $\Delta\chi^2$ (2) = 9.71, $p < .05$, and this model did not reflect a significant difference from the model in which the six structural paths were allowed to vary, $\Delta\chi^2$ (4) = 4.48, p > .10. The structural paths from this final model (in which only four paths were held invariant) are presented in Table 13. One may note in the table that paths that were held invariant do differ slightly between samples. This is because some elements of the model, such as the variances of the latent variables, were allowed to vary between groups, thereby affecting the standardized solutions.

Table 13

Path Estimates From Multiple-Groups Model

Criterion and Predictor	Mathematics, Physical Science, and Engineering	Biological Sciences
Self-Efficacy		
Year in Program	.20*	.24*
Ability	.54	.34
Positivity of Role Model Influence	.42	.26
Role Conflict		
Positivity of Role Model Influence	-.40*	-.51*
Career Aspirations		
Self-Efficacy	.33*	.25*
Role Conflict	-.30*	-.25*

Note. *Paths constrained to be equal between groups. All paths significant at $p < .05$.

CHAPTER 5

DISCUSSION

This study examined female students' experiences in non-traditional college majors. Theoretically relevant variables were simultaneously examined for their associations with career aspirations in math, the physical sciences, and engineering and with career aspirations in the biological sciences. In addition to findings from the structural equation modeling procedure, findings from the examination of mean differences between the two samples were noteworthy. A discussion of the findings with respect to means, frequencies, and group differences is presented after a more detailed discussion of the modeling procedures and results. Chapter 5 concludes with a discussion of the limitations of the present study and the contributions that this project makes to the field of women's career development in non-traditional fields.

Discussion of the Theoretical Model

Results for the Combined Sample of Women

The theoretical model was well supported by data from the combined sample of women in math, physical sciences, and engineering majors and women in biological science majors. As hypothesized in Chapter 1, self-efficacy was an important direct predictor of career aspirations. Although previous research had shown self-efficacy to be associated with consideration of science and engineering careers (Betz & Hackett, 1983; Lent et al., 1986, 1987), persistence in science courses (Deboer, 1984), and persistence in science majors (Lent et al., 1984), the relationship between self-efficacy and career aspirations had not directly been tested. The significant, positive relationship between self-efficacy and career aspirations for women in math, science, and engineering suggested self-efficacy continues to play a role in women's career decisions even beyond persistence in undergraduate majors. A woman's confidence in her ability to complete a number of academic milestones seems to be positively associated with the degree to which she aspires to top-level or leadership positions within the sciences, math, or engineering.

The model tested in this study also showed that role conflict was a direct predictor of career aspirations. This hypothesis was based on research conducted by Dukstein and O'Brien (1995) in which college women's confidence in their ability to combine work and family responsibilities was shown to be positively related to their career aspirations. The current study revealed the relationship between role conflict and career aspirations holds for the two groups of women in science, math, and engineering; beliefs that science careers are compatible with marriage and family responsibilities were associated with higher career aspirations among women in the combined sample.

Year in program, ability, and positivity of role model influence played more distal roles in women's career aspirations. These three constructs were each significantly associated with career aspirations, as mediated by their association with self-efficacy. Consistent with Bandura's (1977) suggestion that self-efficacy is derived, in part, from previous performance accomplishments, year in program was shown to be positively related to the self-efficacy expectations of women in this study. It appears that, as these women advance through their undergraduate programs, they have had more successful experiences in their programs, and this contributes to a greater confidence in their abilities to complete a number of academic milestones in their fields. In addition, this study suggested that self-efficacy may be predicted by role model influence. Consistent with Bandura's (1977) research showing that observing role models complete a task successfully may affect self-efficacy expectations, this study indicated that being positively influenced by role models may increase a woman's own self-efficacy expectations for achieving specific academic milestones in non-traditional fields. Finally, this study extended Betz and Hackett's (1981) finding that self-efficacy mediated the relationship between ability and perceived range of career options by showing that self-efficacy also mediates the relationship between ability and actual career aspirations in non-traditional fields.

This study also found role conflict to be a mediator of the relationship between positivity of role model influence and career aspirations. It appears that women who have been influenced positively by role models are more likely to believe that math, science, and engineering careers are compatible with family and marriage responsibilities which, in turn, is associated with higher career aspirations in these fields. Very little previous research has investigated the specific avenues through which role model influence affects women's career decisions, and this study suggests that one potential avenue is by demonstrating ways in which multiple roles can be negotiated or by persuading women that they are capable of handling multiple roles.

Differences Between the Two Groups

Although the theoretical model was supported by data from women in the combined sample, there were significant differences in the relationships between variables for the group of women in math, physical science, and engineering majors and the group of women in the biological science majors. An examination of differences between the two groups of students suggested that relationships between (a) ability and self-efficacy and (b) positivity of role model influence and self-efficacy were significantly stronger for the women in math, physical science, and engineering majors. Because these analyses were conducted a posteriori, caution should be used when drawing conclusions, and replication of the results is clearly warranted.

Although it is only possible to speculate about the nature of these differences, it seems possible that women in male-dominated majors (i.e., math, physical sciences, and engineering) feel as though performing well in school is a greater challenge for them than do women in the more gender-balanced biological sciences. Performing well academically clearly has an effect on self-efficacy, and the present sample of women in the math, physical science, and engineering group was performing very well overall based on standardized test scores and grade point averages. It seems reasonable to surmise that these women may believe their ability is particularly strong since they are succeeding at tasks that they see very few women doing. Women in the biological sciences were also doing well as a group, but because these fields are more gender-balanced, they may not feel that their ability is as remarkable or out of the ordinary. As a consequence, their self-efficacy may not receive as great a boost from indicators of successful academic ability, thus accounting for the weaker relationship between ability and self-efficacy for this group.

A related possibility is that the self-efficacy expectations of women in the biological sciences are based more strongly on other sources of information. Bandura (1977, 1986) suggested that two other sources of information from which people derive self-efficacy expectations are verbal persuasion and emotional arousal. It may be that women in the biological sciences have been persuaded to a greater degree (e.g., from guidance counselors or parents) to remain in their fields or to aspire to advanced-level careers or that they tend to draw self-efficacy beliefs from emotional reactions than do women in the more technical fields. Unfortunately, these questions remain to be answered through future research as the data provided by the participants in this study do not allow for an analysis of the specific nature of the differences in these relationships for the two groups.

Group Differences on Individual Variables

In order to learn more about the differences between women in the physical sciences, math, and engineering and women in the biological sciences, the two groups were compared on a number of demographic and predictor variables. Perhaps the most striking finding was the similarity of women in the two groups on a number of variables. Comparisons of the two groups on a number of demographic variables suggested they had very similar backgrounds.

The two groups did not differ in terms of the highest level of education attained by their parents and siblings, marital status, parental status, plans to marry in the future, anticipated age of marriage, and number of children anticipated.

The two groups did differ, however, in terms of the anticipated age of having the first child. Women in the mathematics, physical science, and engineering group anticipated having their first child at a slightly, but statistically significantly, older age than did those in the biological sciences. Although women in the two groups did not differ in terms of overall anticipated role conflict, it is possible that women in the physical sciences, math, and engineering perceive a need to have more time to become established in their careers before beginning a family. Perhaps these women anticipate that they will need to spend the early years of their employment putting the majority of their energy into work responsibilities in order to establish themselves as serious or worthy professionals. It is possible that they anticipate needing to avoid appearing distracted by family responsibilities so that they are not passed over in job promotions or opportunities when they are compared to their male colleagues who would represent a majority of their co-workers. Again, additional research is needed to investigate the factors accounting for this difference.

Differences between the two groups existed in terms of aptitude but not achievement. Women in the math, physical science, and engineering majors had significantly higher average ACT/SAT scores than those in the biological science group, whereas the two groups did not differ in terms of average GPA. This is likely a selection issue, such that math, physical science, and engineering majors have more competitive entrance requirements than do biological science majors. Alternatively, it may be that the non-traditionality of mathematics, physical science, and engineering majors for women resulted in a case whereby only women who felt extremely confident in their ability (as measured by ACT/SAT scores) entered into these majors.

This latter explanation is supported by the differences observed in self-efficacy for academic milestones in math, science, or engineering fields. There were significant differences between the two groups on three of the four factors comprising the Self-Efficacy for Academic Milestones measure. Women in the math, physical science, and engineering majors scored higher on the factors reflecting excelling in the field, getting into and competing successfully in graduate school programs, and completing specific class requirements. It is possible that women in the math, physical science, and engineering group really did feel more efficacious in these areas; perhaps only women with high self-efficacy expectations for these three sets of tasks entered into the math, physical science, and engineering majors in the first place. Another alternative is that women in the biological sciences, for some reason, had lower self-efficacy as a result of their experiences in these fields. A final possibility is that self-efficacy meant something different for women in the two groups. Although the instructions for this measure specifically instructed participants to rate their confidence in their ability to complete the tasks assuming they were motivated to do so, they may have had a hard time estimating their confidence in tasks they perceived as irrelevant to them. Women in the biological sciences group, for example, may have rated themselves as having lower confidence for some courses (e.g., completing the physics requirements) because these classes were not required or relevant for their majors.

Limitations of the Study and Suggestions for Future Research

The results observed in the present study need to be qualified by the study's limitations. First, the data obtained for the study were drawn from a single institution. As a consequence, despite the high response rate for participants in the study, the ability to generalize results from this study to all mathematics, science, and engineering programs is severely limited. The students in this study had ACT/SAT scores that were higher than the national average, and it is reasonable to assume they may have differed from students in programs in other ways as well.

The large majority of students in this study were Caucasian females who were in their late teens and early twenties. The generalizability of this model to students of diverse ethnicities or who are returning to school in later life is unknown. It is very likely that the model would fit quite differently, for example, in a sample of women who have had more life experience and who have already entered into marriage and/or parenthood. Evaluating this model by collecting data from a more diverse sample of participants may suggest a need for altering the model in some way for women with these characteristics.

Although many of the measures used in this study have been shown to be reliable and valid in previous research, three of the items assessing role model influence were written specifically for this study and had a comparatively low reliability estimate. The development of more complete and psychometrically sound measures of role model influence are warranted and would strengthen future investigations of this construct. In addition, many of the items used in this study had a restricted range, thus potentially underestimating the magnitude of the relationships between constructs. Future studies may benefit from the development of scales designed to produce a broader range of responses among highly talented students.

Finally, data from this study were not experimental, nor were they longitudinal. As such, cause-and-effect relationships were impossible to establish. Although structural equation modeling allows one to postulate causal relationships, this model specification is based on previous research and theory, not on the actual data. As a consequence, the cause-and-effect relationships suggested by the model in this study may not represent the true nature of the relationships among the constructs. Future research will benefit from the collection of longitudinal data in order to more precisely measure change across time and the direction of causality among relationships. Ideally, this research will begin tracking students who are in elementary school and will continue until these students have entered the world of work. In addition, it may be useful to experimentally manipulate factors of interest, thereby enabling more definite conclusions about causal relationships to be drawn.

Implications for Intervention

While some caution in interpreting the results of this study is warranted given the limitations of the design, the findings suggest a number of implications for interventions designed to increase the numbers of women pursuing top-level careers in math, the physical sciences, and engineering. First, the findings suggest that instruments measuring self-efficacy and role conflict would help identify students who are less likely to have high career aspirations in these fields. Accurate identification of these students would help programs focus specifically on their needs.

The finding that self-efficacy expectations are important predictors of career aspirations suggests that interventions designed to increase students' self-efficacy for academic milestones should be beneficial. Students in these fields may benefit from career counseling interventions, such as cognitive techniques, that are designed to increase self-efficacy by challenging women to note their successes in the field and draw upon previous experiences which suggest they are capable of handling the requirements necessary to complete their degrees. Many students who earned excellent grades in high school report that they are shocked by their lower test scores in difficult college courses. Instead of assuming that their low test scores are indicative of a lack of ability to succeed in these courses, career counseling interventions could encourage women to compare their experiences with other students' experiences in order to normalize their struggles.

Second, this study suggests that role models play an important role in the career aspirations of women in the technical fields. They appear to be associated with career aspirations through their influence on self-efficacy expectations and through their influence on role conflict. Given the importance of role models on these variables, interventions designed to increase students' access to role models are clearly warranted. Programs could accomplish this by inviting guest speakers into courses, by establishing peer mentoring programs, and by including a discussion of the lives of influential scientists, mathematicians, and engineers into course curricula.

The finding that fathers and mothers were the two types of role models most frequently nominated by participants as affecting their decisions to pursue careers in math, science, and engineering suggests that interventions designed to capitalize on family influences may be beneficial. One possible intervention would be to hold parent information sessions during freshman orientation meetings prior to students' arrival on college campuses. These sessions could stress to parents the importance of their influence on students' career aspirations and provide suggestions about ways in which they could give encouragement to their daughters who are pursuing careers in these fields. For example, parents could be given information about various types of occupations in math, science, and engineering and the importance of these careers to society so that they could convey this information to their children.

Third, interventions designed to reduce the amount of role conflict students experience appear to hold promise for increasing their career aspirations in math, science and engineering. Such interventions could include providing access to role models who are successfully combining family and work responsibilities. Unfortunately, many students may know very little about their instructors' and other professionals' personal lives. The findings of this study suggest that providing opportunities for students to interact with their instructors on a more informal basis and to know more about their lives outside the classroom may be beneficial. Allowing their students to observe how they combine work and family responsibilities may be an important way in which instructors could contribute to their students' professional development and professional goals.

At the organizational level, another potential intervention would be to restructure math, science, and engineering work environments so that the roles of worker and family member are perceived by women as more compatible. Some possibilities would be to increase the degree to which opportunities for job-sharing, part-time work, or on-site child-care resources are available. A combination of interventions targeted at the individual level and at the environmental level would likely be ideal.

Unique Contributions of the Study

This study was designed to explore factors that affect women's plans to reach upper-level positions within the math, physical science, and engineering work forces. Given the United States Department of Labor's (1994) identification of lack of participation in upper-level positions as the major barrier to equity in the science and engineering labor forces, such research is clearly needed. Unfortunately, the majority of research has ignored this aspect of the career development of women in science and engineering fields, instead focusing on initial attraction to and persistence in undergraduate college majors. Thus, the current study added significantly to an understanding of women's vocational development by investigating a critical point in the science and engineering pipeline that, thus far, has received little attention.

This study also investigated relationships among two sets of variables that have not previously been tested. Although the relationship between role model influence and role conflict and the relationship between self-efficacy expectations and career aspirations were theoretically meaningful, they had not previously been empirically studied. Because of the potential of these relationships to help explain women's underrepresentation in the science and engineering work forces, the inclusion of these variables in the model specified in this study was believed to be a significant contribution to the existing literature on women's career development. This study documented evidence supporting these relationships in a sample of women in math, science, and engineering majors.

Finally, to test the generalizability of this model to women in traditionally male fields which are now made up of approximately equal numbers of men and women, the model was applied to a combined sample of women in math, physical science, and engineering majors and women in biological science majors. The variables selected for inclusion in this model have been tested primarily in samples of women in educational and occupational fields in which women are drastically underrepresented. Little has been known about the effects of these variables on women who are in non-traditional majors that are currently gender balanced. Thus, the present study added significantly to the literature on women's career development by contrasting the experiences of women in male-dominated and gender-balanced educational majors. While the experiences of women in the two groups appeared to be similar in many ways, some important differences with respect to self-efficacy, academic ability, and plans for parenthood were highlighted. These differences may provide a focus for further exploration and understanding of reasons for the underrepresentation of women in some, but not all, traditionally male fields.

Conclusions

The variables that affect women's career aspirations in math, science, and engineering are complicated and warrant extensive investigation. This study examined the fit of a model predicting career aspirations among women in math, physical science, and engineering, and it contrasted this fit with the fit of the same model tested on a sample of women in biological science majors. The model, which included ability, self-efficacy, positivity of role model influence, and role conflict as predictors of career aspirations, represented a good fit to the data.

Important implications for research and for interventions stem from the current findings. Interventions designed to increase women's self-efficacy expectations and decrease the degree to which they perceive science careers as incompatible with family responsibilities are warranted. Ideally, future research will involve longitudinal or experimental designs in order to provide more conclusive evidence for the relationships suggested by the model in this study. Although the resources needed to conduct such studies are enormous, the costs associated with the chronic underrepresentation of women in non-traditional fields that are incurred both by individual women and by society would almost certainly outweigh those that would be expended by extensive research in this area.

APPENDIX A

DEMOGRAPHIC ITEMS

I. Please provide the following information about yourself. This information will be used only to assess for differences among groups of people and to report characteristics of the final sample of respondents. It will in no way be used to identify you individually.

Age: ____

Ethnicity: (please circle)

1. Caucasian American
2. Asian American
3. African American
4. Hispanic, Latino (a)-, or Chicano (a)- American
5. Native American
6. Other (please specify ________________)

Year in School: (please circle)

1. Freshman
2. Sophomore
3. Junior
4. Senior
5. Fifth-year senior or beyond

Number of college credits you have earned: ________

Current academic major: ________________________

Academic major in which you anticipate earning a Bachelor's degree : ____________________

Occupation you are pursuing: ________________________

For approximately how many years do you plan to work in the occupation you are pursuing? ______

What is the highest level of education you plan to attain? (please circle)

1. Some college
2. Bachelor's degree
3. Master's degree
4. Doctoral degree or Professional degree (e.g., Law, Medicine, etc.)

Please place an "X" in each column below to indicate the **highest** level of education attained by these relatives of yours.

	Father	**Mother**	**Sibling with the most education**
1. Less than high school	____	____	____
2. High school	____	____	____
3. Technical or Vocational School	____	____	____
4. Bachelor's degree	____	____	____
5. Master's degree	____	____	____
6. Doctoral degree	____	____	____

Father's occupation: ____________________

Mother's occupation: ____________________

Are you currently married?

1. No 2. Yes

If you are not married, do you plan to marry at some point?

1. No 2. Yes (please specify approximate age at which you might marry ______)

Do you currently have children?

1. No 2. Yes (please specify number of children ________________)

If you do not currently have children but plan to in the future, please indicate the following:

1. Approximate age at which you anticipate having the first child _______
2. Number of children you anticipate having _______

APPENDIX B

SELF-EFFICACY FOR ACADEMIC MILESTONES IN TECHNICAL AND SCIENTIFIC FIELDS SCALE

For each task listed below, please indicate whether or not you feel you could successfully complete it – assuming you were motivated to make your best effort. For each YES, indicate how sure you are by circling one of the numbers on the 10-point scale.

Task	Could you successfully complete the task?		If yes, how sure are you? Completely Unsure ... Completely Sure
1. **Complete the math requirements for most science, math, or engineering majors**	Yes	No	1 2 3 4 5 6 7 8 9 10
2. **Complete the chemistry requirements for most science, math, or engineering majors**	Yes	No	1 2 3 4 5 6 7 8 9 10
3. **Complete the physics requirements for most science, math, or engineering majors**	Yes	No	1 2 3 4 5 6 7 8 9 10
4. **Complete some science, math, or engineering degree**	Yes	No	1 2 3 4 5 6 7 8 9 10
5. **Perform competently in some science, math, or engineering career field**	Yes	No	1 2 3 4 5 6 7 8 9 10
6. **Remain in a science, math, or engineering major over the next semester**	Yes	No	1 2 3 4 5 6 7 8 9 10
7. **Remain in a science, math, or engineering major over the next two semesters**	Yes	No	1 2 3 4 5 6 7 8 9 10
8. **Remain in a science, math, or engineering major over the next three semesters**	Yes	No	1 2 3 4 5 6 7 8 9 10
9. **Excel in science, math, or engineering over the next semester**	Yes	No	1 2 3 4 5 6 7 8 9 10
10. **Excel in science, math, or engineering over the next two semesters**	Yes	No	1 2 3 4 5 6 7 8 9 10
11. **Excel in science, math, or engineering over the next three semesters**	Yes	No	1 2 3 4 5 6 7 8 9 10
12. **Be accepted into a science, math, or engineering graduate program, law school, or medical school**	Yes	No	1 2 3 4 5 6 7 8 9 10

13. **Successfully obtain a science, math, or engineering graduate degree, a law degree, or a medical degree**	Yes	No	1 2 3 4 5 6 7 8 9 10
14. **Excel in a science, math, or engineering graduate program, a law program, or a medical school program**	Yes	No	1 2 3 4 5 6 7 8 9 10

APPENDIX C

INFLUENCE OF ROLE MODELS SCALE

Please rate the degree to which each of the following people has been influential in **your decision to major in and stay in science, math, or engineering.** A person would have a "**negative influence**" if he/she discouraged you in some way from pursuing or staying in science, math, or engineering. A person would have a "**positive influence**" if he/she encouraged you in some way to pursue or stay in science, math, or engineering. A person would have a "**neutral influence**" if he/she neither encouraged nor discouraged you from pursuing or staying in science, math, or engineering. If an item does not seem to apply to you, please circle "N/A".

	negative influence		neutral influence			positive influence		not applicable
1. **Mother**	-3	-2	-1	0	1	2	3	N/A
2. **Father**	-3	-2	-1	0	1	2	3	N/A
3. **Sister(s)**	-3	-2	-1	0	1	2	3	N/A
4. **Brother(s)**	-3	-2	-1	0	1	2	3	N/A
5. **Female math, science, or engineering teacher(s)**	-3	-2	-1	0	1	2	3	N/A
6. **Male math, science, or engineering teacher(s)**	-3	-2	-1	0	1	2	3	N/A
7. **Other female teacher(s)**	-3	-2	-1	0	1	2	3	N/A
8. **Other male teacher(s)**	-3	-2	-1	0	1	2	3	N/A
9. **Female friend(s)**	-3	-2	-1	0	1	2	3	N/A
10 . **Male friend(s)**	-3	-2	-1	0	1	2	3	N/A
11. **Female adult(s) (aunt, grandmother, family friend, etc.)**	-3	-2	-1	0	1	2	3	N/A
12. **Male adult(s) (uncle, grandfather, family friend, etc.)**	-3	-2	-1	0	1	2	3	N/A
13. **Women employed in math, science, or engineering**	-3	-2	-1	0	1	2	3	N/A
14. **Men employed in math, science, or engineering**	-3	-2	-1	0	1	2	3	N/A

APPENDIX D

ADDITIONAL ROLE MODEL QUESTIONS

For the following questions, please think of **the one person** who has had the **most positive influence** on your decision to pursue a career in science, math, or engineering.

What is this person's sex?

1. Male 2. Female

What is this person's relationship to you? (please circle)

1. Mother
2. Father
3. Sister
4. Brother
5. Female math, science, or engineering teacher
6. Male math, science, or engineering teacher
7. Other female teacher
8. Other male teacher
9. Female friend
10. Male friend
11. Other female adult
12. Other male adult
13. Woman employed in math, science, or engineering
14. Man employed in math, science, or engineering
15. Other (please specify________________)

What is the highest level of education this person has completed?

1. Less than high school
2. High school
3. Technical or vocational school
4. Bachelor's degree
5. Master's degree
6. Doctoral degree

What is this person's approximate age? ________

Is this person employed?

1. No 2. Yes (Please list his/her occupation: ________________________)

Please continue to think of the one person who has been most influential in your decision to pursue a science, math, or engineering career. For the next three items, please use the following scale to indicate **your perception of the person who has had the most positive influence** on your decision to pursue a science, math, or engineering career:

	Very little				A great deal
1. **To what extent has this person encouraged you to complete a bachelor's degree in science, math, or engineering?**	1	2	3	4	5
2. **To what extent has this person encouraged you to pursue a graduate degree in science, math, or engineering or a law or medical degree?**	1	2	3	4	5
3. **To what extent has this person had an influence on your life in general?**	1	2	3	4	5

Still thinking of the person who has had the most positive influence on your decision to pursue a science, math, or engineering career, please use this scale to rate your perceptions of the person.

	Not very Successful			Very Successful		Does not apply to this person
1. **How successful is this person at combining a career and marriage responsibilities?**	1	2	3	4	5	N/A
2. **How successful is this person at combining a career and family responsibilities?**	1	2	3	4	5	N/A

Please indicate the number of people you have known personally in each of the following categories:

Female math teachers _____

Female science teachers _____

Female engineering teachers _____

Female mathematicians _____

Female scientists _____

Female engineers _____

Male math teachers _____

Male science teachers _____

Male engineering teachers _____

Male mathematicians _____

Male scientists _____

Male engineers _____

APPENDIX E
ATTITUDES TOWARD THE COMPATIBILITY OF SCIENCE CAREERS WITH MARRIAGE AND FAMILY RESPONSIBILITIES SCALE

Please rate your agreement with each of the following statements by circling the appropriate number to the right.

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

APPENDIX F

CAREER ASPIRATION SCALE

Please circle the number which best represents your perception of yourself and your plans for the future. Please be completely honest. Your answers are entirely confidential and will be useful only if they accurately describe you.

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

APPENDIX G

LETTER ACCOMPANYING QUESTIONNAIRE PACKET

MAILED TO STUDENTS

IOWA STATE UNIVERSITY
DEPARTMENT OF PSYCHOLOGY
W112 Lagomarcino, Ames, Iowa 50011-3180

September 15, 1996

Dear Iowa State University Student,

As a woman enrolled in science or engineering, you are among a very select group of people. Your experiences may be somewhat different from those of students in other majors, and I am very interested in your perceptions of science and engineering majors and careers because you may be able to provide insight that will help facilitate other women's entrance into and persistence in those fields.

You have been selected to take part in a research study at Iowa State University. I am collecting information about factors that may influence peoples' choices about whether to pursue and persist in college majors and occupations in technical majors. The information you provide will add a valuable component to our knowledge of how students make educational and occupational decisions, which will help guide future programs designed to meet students' needs. By completing the attached questionnaire, you also may benefit by gaining a better understanding of your own experiences, values, and beliefs, and how those factors influence your vocational choices.

Your participation in this project is completely voluntary, and your identity will be kept confidential. You will notice that your name appears only on the informed consent form. However, there is a four-digit code that appears on both the consent form and the questionnaire. After you send in your completed survey, the consent form will be removed from your questionnaire and kept in a separate location. Thus, your responses on the questionnaire will not be able to be linked to you by anyone but me. I need to be able to link your code to your name because I would like to be able to verify, with your permission, your ACT/SAT scores and cumulative grade point average with the registrar's records. This information is needed to help me understand your academic background. Only group data will be reported and analyzed, and information on individuals will not be provided to anyone.

The questionnaire will take approximately 20 minutes for you to complete. When you finish, please make sure you have signed the informed consent form and mail it and the questionnaire back to me in the postage-paid envelope. Please feel free to call me at 294-8480 if you have any questions about the study or the survey. You may also contact my advisor, Dr. Douglas Epperson, at (515) 294-2047.

I know that your time is valuable, and to thank you for participating in this study, I would like to enter your name in a drawing that will be held on October 31, 1997. From the questionnaires that have been completed and returned to me **prior to October 31** I will randomly select three names, and those individuals will win **$100.00** prizes.

Thank you for considering participating in this important study. I look forward to learning more about your experiences and perceptions.

Sincerely,

Margaret M. Nauta, M.S. Douglas L. Epperson, Ph.D.

APPENDIX H

CONSENT FORM

Consent Form

Please indicate whether you are willing to participate in this study under the conditions described in the cover letter by placing an "X" next to one of the options and signing below.

_____ Yes, I am willing to participate in the study under the conditions described in the cover letter.

_____ No, I do not wish to participate in the study. (If you select this option, please return this form along with the blank questionnaire in the envelope provided so that I will know that I should not try to contact you again for participation in this study.)

Signature_______________________________________ Date ______________

==

In order to understand more about you and your experiences, I would like to be able to obtain your ACT and/or SAT scores and cumulative grade point average from the Iowa State University Registrar's office. If you would permit this, please check the appropriate box and sign below. These scores are an important part of this data set. Please remember that your name will be removed from the scores as soon as they are received, and all information in this study will be completely confidential.

____ Yes, you have permission to obtain my ACT and/or SAT scores and grade point average from the Registrar's Office.

____ No, you do not have permission to obtain my ACT and/or SAT scores and grade point average from the Registrar's Office.

Signature _______________________________________ Date ______________

==

Please indicate whether or not I may enter your name in the drawing for **one of three $100.00 prizes** to be awarded on **October 31, 1996.**

_____ Yes, please enter my name in the drawing. Should I be selected as a winner, please send the prize to me at the following address:

____

____

____

_____ No, please do not enter my name in the drawing.

APPENDIX I

POSTCARD REMINDER

Dear Student,

Just a reminder...

About 2 weeks ago, you should have received a survey asking you some questions about yourself, your beliefs, and your experiences in science and engineering. If you have already completed and returned the survey, we thank you. If you have not, please take the time to do so. Your input is critical to the success of this study. Please remember to complete and return your survey **prior to October 31, 1996** in order to be eligible to win one of three $100.00 prizes that will be awarded to randomly selected students whose questionnaires are returned by the deadline.

Thank you!

Margaret M. Nauta Douglas L. Epperson Department of Psychology
Iowa State University

APPENDIX J

FOLLOW-UP LETTER

IOWA STATE UNIVERSITY
DEPARTMENT OF PSYCHOLOGY
W112 Lagomarcino, Ames, Iowa 50011-3180

October 21, 1996

Dear Iowa State University Student,

About a month ago I sent you a survey asking you some questions about you and your experiences in science, mathematics, and engineering. As a woman enrolled in one of these fields, you are in the unique position of being able to provide insight that will help facilitate other women's entrance into and persistence in fields that have traditionally been male-dominated. Because you are one of a small number of women enrolled in these fields at Iowa State University, your input is extremely critical to the success of this study.

I have not yet received a completed survey from you, however, and I am uncertain about your desire to participate in the study. If you have decided not to participate, please simply ignore this letter and survey. If you did not receive the initial survey or if you have misplaced the survey but would still like to participate, I am enclosing a second, identical questionnaire for you to return in the postage-paid envelope.

As before, your participation in this project is completely voluntary, and your identity will be kept confidential. You will notice that your name appears only on the consent form. However, there is a four-digit code that appears on both the consent form and the questionnaire. After you send in your completed survey, the consent form will be removed from your questionnaire and kept in a separate location. Thus, your responses on the questionnaire will not be able to be linked to you by anyone but me. I need to be able to link your code to your name because I would like to be able to verify, with your permission, your ACT/SAT scores and cumulative grade point average with the registrar's records. This information is needed to help me understand your academic background. As soon as your ACT/SAT scores and GPAs have been linked to your responses on the rest of the survey, I will remove your name from the list of scores, leaving only the four-digit code attached to your scores in order to ensure confidentiality. Only group data will be reported and analyzed, and information on individuals will not be provided to anyone.

The questionnaire will take approximately 20 minutes for you to complete. When you finish, please make sure you have signed the consent form and mail it and the questionnaire back to me in the postage-paid envelope. Please feel free to call me at (515) 294-8480 if you have any questions about the study or the survey. You may also contact my advisor, Dr. Douglas Epperson, at (515) 294-2047.

I know that your time is valuable, and to thank you for participating in this study, I would like to enter your name in a drawing that will be held on October 31, 1996. From the questionnaires that have been completed and returned to me prior to October 31, I will randomly select three names, and those individuals will win $100.00 prizes.

Thank you for considering participating in this important study. I look forward to learning more about your experiences and perceptions.

Sincerely,

Margaret M. Nauta, M.S.

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