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Women's Choice in College STEM Majors: Impact of Ability Tilt on Women Students' Educational Choice

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by

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Dr. Diane Coursol, Dissertation Advisor

ABSTRACT

This quantitative study explored the impact of ability and ability tilt on the choice of an academic program in STEM majors for female college students who have not been identified as profoundly or highly gifted. A math tilt would be an ability tilt slanting toward math. The career development theory that provided a framework for this study was the Theory of Work Adjustment. Three bodies of literature were reviewed, (a) Self-efficacy as a variable in college major or career choice, (b) life-style preference, and (c) ability tilt and ability. A Chi Square Test of Independence determined that significantly more women who majored in inorganic science, math or engineering exhibited a math tilt than would be expected. By using a logistic regression, it was found that women who possessed a math tilt were more likely to choose an inorganic science, math or engineering major. There are limitations to this study, but results suggested that further study into the concept of an ability tilt driving the choice of a major for women college students should be further explored.

TABLE OF CONTENTS

Women's Choice in College STEM Major: Impact of Ability Tilt on Women Students' Educational Choice

CHAPTER ONE

INTRODUCTION

Background

The Civil Rights Act of 1964 enabled women to pursue occupations that had been denied to them because of discrimination based on sex. Since the 1960s career development researchers have focused on the career needs of women, helping women to realize their career potential (Farmer, 1997). Despite this focus, in 1997, only 5.7% of all women in the workforce were employed in occupations considered nontraditional for females (AFSCME, 2002).

The U.S. Department of Labor considers a nontraditional occupation to be one in which females make up 25% or less of the total work force (AFSCME, 2002). Examples of nontraditional occupations include, but are not limited to: construction managers, engineering managers, computer software engineers, computer programmers, mechanical engineers, aerospace engineers, fire fighters, logging workers, carpenters, mining machine operators, and civil engineers (Bureau of Labor Statistics, 2011). Traditional female careers are thought of as those in which women make up 95% or more of the work force (Chatterjee & McCarrey, 1989). However, other research has suggested that traditional occupations are those where women make up 85% or more of the work force (Whiston, 1993). Examples of traditional occupations for women include, but are not limited to: preschool and kindergarten teachers, speech-language pathologists, dental hygienists, dental assistants, childcare workers, secretaries, and administrative assistants (Bureau of Labor Statistics, 2011).

The National Employment for Women Act mandated that states develop goals for the training and placement of women in nontraditional jobs (U.S. Department of Labor, 2004). This focus was partially based on advantages of working in characteristically nontraditional jobs. Two significant advantages of work in nontraditional jobs for women include better benefits and better pay. Data compiled in 2002 indicated that salaries for nontraditional occupations were reported to be 20% to 30% more than for traditional female jobs (AFSCME, 2008). Occupations in the trades and technical fields also often offer better health benefits and sick leave time than traditionally female occupations (AFSCME, 2008).

For the past 20 years, nontraditional careers have been more open to women; however, men and women have continued to enter jobs and educational programs based on perceived sex appropriateness (Betz & Hackett, 1981; Eccles, 1994; Evetts, 1993; Gottfredson, 1981; Whiston, 1993). Thus, women have continued to not only be under represented in many occupations, particularly careers in science, technology, engineering, and math (STEM), but they also have continued to be over represented in low pay and low status occupations (Betz & Fitzgerald, 1987; Scheye & Gilroy, 1994) with few opportunities for advancement (Betz & Fitzgerald, 1987), thus, demonstrating a gender gap. While the gender gap is closing in some fields such as law and biology (Lubinski, Benbow, Shea, Eftekhari-Sanjani, & Halvorson, 2001), when women choose a profession in a science related field, it often tends to be a lower prestige career than careers that men choose. For instance, women tend to choose careers in the helping sciences like nursing and health technicians (Farmer, 1997). In contrast, men choose science careers in engineering or "at the physician level within the health fields…" (Farmer, 1997, p. 386). Women who possess math and science abilities tend to pursue organic sciences, such as biology or health sciences, and humanities while men who possess math and science abilities tend to pursue engineering and inorganic science, such as chemistry or physics (Lubinski, Benbow et al., 2001). Even when women aspire to nontraditional STEM-based occupations they tend to leave the field, known in the literature as *dropping out of the pipeline* (Mau, Dominick, & Ellsworth 1995; Subotnik & Steiner, 1993). In one longitudinal study, 83% of women aspiring to a nontraditional occupation in twelfth grade were no longer in the pipeline seven years later (Frome et al., 2006). Although the nontraditional careers in this study were not limited to STEM, such nontraditional careers as engineers and chemists were included.

Research findings also indicated that there are fewer U. S. mathematicians and engineers being developed by the American educational system (Adair, 1991). It has been noted that students in other countries exhibit greater science achievement than students in the United States (Stake & Nickens, 2005). In the United States, six percent of bachelor's degrees conferred in engineering are to "nonresident aliens" (Digest of Education Statistics, 2010). That percentage rises exponentially with masters and doctoral degrees in engineering. Nonresident aliens comprised 43% of the master's degrees conferred and 58% of doctoral degrees conferred in U. S. higher education institutions (Digest of Education Statistics, 2010). In addition, the research indicated that there is a significant gap between males and females enrolled in these programs (Lubinski, Benbow et al., 2001). Recruiting and assisting females to persist in STEM programs will decrease the gender gap in STEM programs and occupations. Furthermore, it will likely increase the number of scientists, mathematicians, and engineers being produced in the U.S. educational systems. There have been attempts to explain reasons for this gender gap in STEM programs. Three rationales for this gap include self-efficacy theory, life style preferences, and math tilt. This paper reviewed the research in these three areas.

Rationale for STEM Imbalance between Males and Females

Self-Efficacy Theory

Historically, hypotheses concerning reasons women may not consider STEM careers have been linked to self-efficacy (Betz & Fitzgerald 1987; Hackett, 1985; Lent, Lopez & Bieschke, 1991; Lindley, 2006; Mau, 2003; Lopez & Lent, 1992; Nevill & Schlecker, 1988; Nauta, Epperson, & Kahn, 1998; Pajares & Miller, 1995; Schaefers, Epperson, & Nauta, 1997; Scheye & Gilroy, 1994; Whiston, 1993). Self-efficacy is defined as a belief in one's ability to succeed in specific situations or at specific tasks. One's sense of self-efficacy can play a major role in how one approaches goals, tasks, and challenges (Bandura, 1977). Bandura submitted that self-efficacy mediated an assurance to the individual that he or she could perform behaviors or tasks necessary for certain outcomes. Self-efficacy also determines how much effort will be expended and how persistent the individual will be.

Authors of earlier studies regarding the lack of women in science occupations suggested that women, compared to men, lacked self-efficacy for nontraditional occupations, particularly in math and science (Betz & Hackett, 1981; Hackett, 1985; Whiston, 1993), and therefore tended to not pursue STEM studies and careers. The studies underrepresentation of women in nontraditional occupations, in particular science, math, and engineering, was attributed to women's self-efficacy

(Betz & Hackett, 1981; Hackett, 1985). In other words, a woman's perceived self-efficacy for success in math or science likely precluded her pursuing STEM studies. Betz and Hackett (1981) posited that due to socialization experiences, males and females varied in their perceived self-efficacy. Thus, sex-type socialization, contributing to self-efficacy, was found to likely be the reason women chose certain careers. Conversely, other research suggested dissimilar findings (Lent, Brown, & Larkin, 1986).

When considering college men and women contemplating science and/or math-related studies and careers, no gender differences were found regarding self-efficacy for "technical/scientific fields" (Lent et al., 1986). Although males may exhibit higher math self-efficacy, these differences may lessen when male and female students have similar prior coursework (Lent et al., 1986). A finding of Pajares and Miller (1995) indicated that self-efficacy in the successful completion of a math course was more predictive of selecting a math major than self-efficacy in solving mathematical problems. Although self-efficacy is linked to academic achievement and persistence, self-efficacy alone was not sufficient in explaining behavior differences seen between males and females in STEM coursework (Lent et al., 1986). Self-efficacy may influence females choosing STEM studies and careers. However, it does not explain why females indicating STEM achievement and interests tend to opt out of the pipeline. While Schaefers and colleagues (1997), found no gender differences in persistent rates of men and women college students, other studies suggested that women opt out of the STEM pipeline at a higher rate than men (Donaldson & Dixon, 1995; Fouad, Hackett, Smith, Kantamneni, Fitzpatrick, Haag, & Spencer, 2010; Mau, 2003).

When comparing women in math-related fields, women in engineering exhibited higher self-efficacy for nontraditional occupations than women math education majors. In contrast, math education majors expressed self-efficacy for traditional jobs (Brown, Eisenber, & Sawilowsky, 1997). An earlier study indicated that women choosing nontraditional careers possessed greater self-efficacy as compared to women choosing traditional careers (Betz & Fitzgereald, 1987). However, Nash and Chrisler (2000) found no difference in measures for self-efficacy between groups of women in traditional occupations and women in nontraditional occupations. In other studies, research results are conflicting in that earlier studies found that women in engineering or other nontraditional careers possessed higher degrees of self-efficacy for nontraditional careers (Betz & Fizgerald, 1987; Brown et al., 1997). More recent research has suggested that there was no difference in self-efficacy between the two groups of women; those in traditional careers versus those in nontraditional careers (Nash & Chrisler, 2000). Betz, Borgen, and Harmon (2006) surmised that self-efficacy alone is not responsible for career choice. They suggested that self-efficacy is related to personality and both of these factors (self-efficacy and personality) are related to interest. They postulated that the overlap of these domains (self-efficacy, personality, and interest) explained career choice, indicating that there is more to be explored to uncover what explains career choice.

Lifestyle Preference

Lifestyle preference is another reason that has been posited for women choosing to not enter STEM careers. Lifestyle preferences refers to how individuals desire to structure their lives surrounding attitudes of "family, personal development, career, social relationships, and community" (Robertson, Smeets, Lubinski, & Benbow, 2010, p. 349). Historically, in the context of lifestyle preferences, females were more concerned with balancing marriage and family with a career than males. As home-family roles become more of a priority, work roles can be compromised (Madill, Montgomerie, Stewin, Fitzsimmons, Tovell, Armour, & Ciccocioppo, 2000). This desire for career and family balance is found not only within STEM careers (Benbow et al., 2000; Ferriman, Lubinski, & Benbow, 2009; Heillbronner, 2012; Lubinski, Benbow, et al., 2001; Lubinski, Webb, Morelock, & Benbow 2001; Lubinski, Benbow, Webb, & Bleske-Rechek, 2006; Robertson et al., 2010), but in other nontraditional occupations as well (Coltrain, 2000; Frome et al., 2006; Madill et al., 2000). Therefore, for many career-oriented women part-time work is an important component (Hallett & Gilbert, 1997). Women often expressed the desire for career and family balance in wanting flexible work hours (Frome et al., 2006), part time work, at least for a period of time (Benbow et al., 2000; Ferriman et al., 2009; Heilbronner, 2012; Lubinski, Benbow et al., 2001; Lubinski, Webb et al., 2001; Roberston et al., 2010) and/or a career that can be combined with a family (Frome et al., 2006). It has also been suggested that perceived home and family obligations may "compromise career aspirations" (Madill et al, 2000, p. 26).

This desire to balance work and family is one reason given for females leaving STEM educational studies or careers in STEM and science related fields (Fox, Schwartz, & Hart, 2006; Frome et al., 2006; Madill et al., 2006). The attitude that female careers in science are not compatible with family life was supported in a study in which women at age 18 years were tracked to age 25 (Frome et al., 2006). This study found that females often chose traditional female careers because these careers appeared to be more flexible with respect to family responsibilities (Frome et al., 2006), thus perceived to be more family friendly than nontraditional careers. For participants in the Study of Math Precocious Youth (SMPY) longitudinal study, females also desired family-friendly jobs. These female participants stated that part time work and/or flexible work schedules were important to them (Benbow et al., 2000; Ferriman et al., 2009; Lubinski, Webb et al., 2001; Lubinski et al., 2006; Webb, Lubinski, & Benbow, 2002). Research suggested that as home and family become more of a priority, work roles can be compromised (Madill et al., 2000). However, the question remains regarding what compels other women to pursue STEM careers even considering marriage, family, and career balance challenges?

Ability Tilt and Ability

One variable contributing to females remaining in the STEM pipeline is what has been referred to in the literature as a math tilt (Webb et al., 2002). For instance, an intellectual math tilt was found when scores on the Scholastic Aptitude Test- Math (SAT-M) were at least one standard deviation above the Scholastic Aptitude Test-Verbal (SAT-V) (Benbow et al., 2000). This math tilt has been found in a longitudinal study, the Study of Mathematically Precocious Youth (SMPY), comprising profoundly gifted males and females being tracked over a 50-year time span (Lubinski & Benbow, 1994). The authors of the SMPY study noted some interesting results related to choice of STEM careers. Participants in the SMPY study took the Scholastic Aptitude Test (SAT) by 13 years of age and, based on their SAT scores, comprised the top 1% of their age group. All participants scored at least 390 on the math portion of the SAT (SAT-M), (Benbow et al., 2000), or at least 370 on the verbal portion of the SAT (SAT-V), (Lubinski & Benbow, 1994).

In this longitudinal study of the top one percent of gifted students in mathematical reasoning, it was found that those students who exhibited a math tilt tended to earn advanced degrees in math/science more than those with "high-flat profiles," or students with SAT-M and SAT-V scores within one standard deviation of each other (Webb et al., 2002). It was further suggested that those women without a math tilt may not merely drop out of the pipeline, but their career trajectories may be propelled into non-STEM careers, making important contributions in other areas (Webb et al., 2002). However, participants who chose career paths other than STEM career paths perceived this change because of interest, not as a result of an ability tilt (Webb et al., 2002). It was suggested that regardless of gender, individuals pursued studies directed toward their intellectual tilt (Benbow et al., 2000), even though the individual may have reported the choice as interest. Again, supporting the assertion that self-efficacy alone is not responsible for career choice (Betz et al., 2006).

Math tilt has been studied in more than just very young adolescents. However, if an individual exhibited a verbal tilt, then a career in the humanities or organic sciences was pursued. Furthermore, women with high math ability, but with a flatter ability profile (no significant difference between SAT math and verbal scores), tended to pursue studies in the organic sciences or humanities rather than inorganic sciences or engineering majors. While ability level may estimate level of achievement, this longitudinal study suggested that ability pattern (e.g., intellectual tilt) predicts the nature of the achievement (Robertson et al., 2010). This is congruent with the Theory of Work Adjustment.

Theoretical Framework

The Theory of Work Adjustment (TWA) will provide a lens for this study when considering the impact of ability and ability tilt. The TWA is concerned with the fit between the individual and the work place (Dawis, 2005). The TWA proposes that the best fit or correspondence is met when the individual's needs are met through the work environment, and the individual performs the requirements of the work environment (Fitzgerald & Rounds, 1994). Thus, a reciprocal relationship is formed by the person's needs being met by the workplace and vice versa (Dawis, 2005). How well the workplace fulfills an individual's needs determines satisfaction. In addition, if the person meets the workplace requirements then satisfactoriness is met (Dawis, 2005).

The TWA proposes that individuals' abilities that meet the ability requirements of an educational or career path represent "satisfactoriness or can do," but when the individuals' interests, values, and needs are met by the career or educational path then, "satisfaction or will do" becomes the optimal situation (Robertson et al., 2010). Thus, women who exhibit high math ability but do not have a math tilt may choose a career not in the STEM pipeline opting for "can do" rather than "will do." In other words, these women who possess high ability and achievement in math may meet the requirements of the workplace (can do/satisfactoriness), but the workplace does not meet the needs of certain women (satisfaction) and they opt out of the pipeline and choose other career paths.

Statement of the Problem

Early studies have suggested that women did not choose STEM careers or college majors due to a lack of self-efficacy (Betz & Fitzgerald, 1987; Hackett, 1985). However, research findings have also suggested that women who excel in mathematics tend to have math self-efficacy (Lent et al., 1986). Although some research findings have suggested that females tend to drop out of the STEM pipeline at a faster rate than males (Donaldson & Dixon, 1995; Fouad et al., 2010; Mau, 2003), other research has suggested that persistence rates for males and females in college STEM studies is similar (Schaefer et al., 1997). Thus, self-efficacy alone does not predict career choice (Betz et al., 2006; Lent et al., 1986).

The literature has also indicated that women tend to be more concerned with balancing career and family as compared to their male counter parts (Corrigal & Konrad, 2007; Donaldson & Dixon, 1995; Frome et al., 2006; Nauta et al., 1998;). As a result, women may choose part time employment (Benbow et al., 2000; Ferriman et al., 2009; Heilbronner, 2012; Lubinski, Benbow et al., 2001; Lubinski, Webb et al., 2001) or flexible work hours or schedule (Frome et al., 2006). While this is useful information, this lifestyle preference does not explain women who enter medicine as opposed to STEM careers, or those who enter organic sciences rather than inorganic sciences. While these results fill in some of the gaps, more needs to be known about what impacts women's career choices in the sciences.

Based on longitudinal studies of the profoundly gifted, females who pursued STEM majors and careers exhibited an ability tilt toward math based on SAT-M and SAT-V scores (Lubinski et al., 2006). Research has suggested that the "ability level predicts level of achievement" while "ability pattern (or tilt) predicts nature of achievement" (Robertson et al., 2010). While all participants exhibited high ability, it was their ability tilt that influenced their career trajectory. Even though all the women in this study exhibited high math scores on the SAT-M, they did not all enter STEM studies or careers. The study suggested that it was the women who exhibited a math tilt on the SAT test who pursued STEM studies or careers.

While these ability tilt studies have been conducted on the profoundly gifted and/or those attending prestigious colleges, more typical college students have not been studied regarding a math tilt. It has yet to be determined if this math tilt is present in more typical college students. Would those females majoring in a STEM or inorganic science, and attending a more conventional college also exhibit this math tilt?

Purpose of the Study

The purpose of this study was to address the research gap that has been identified in the preceding section; that is, to explore the impact of ability and ability tilt on the choice of an academic program for female college students who have not been identified as profoundly or highly gifted.

Even though the National Employment for Women Act mandated that states develop goals for the training and placement of women in nontraditional jobs (U.S. Department of Labor, 2004), females have continued not only to be under-represented in many occupations, particularly careers in science, technology, engineering, and math (Bureau of Labor Statistics, 2012; National Science Foundation, 2008), but also they have continued to be over-represented in low pay and low status occupations (Betz & Fitzgerald, 1987; Sheye & Gilroy, 1994). Additionally, there are fewer U. S. mathematicians and engineers being developed by the American educational system (Adair, 1991), and because women have continued to be under-represented in these areas, it is logical to view women as an untapped potential. It has been established that profoundly gifted females who pursued STEM studies and careers exhibited an ability tilt toward math based on SAT-M and SAT-V scores (Lubinski et al., 2006). It is suggested that the "ability level predicts level of achievement" while "ability pattern (or tilt) predicts nature of achievement" (Robertson et al., 2010). However, this longitudinal study was conducted on profoundly gifted females; would this ability tilt be found in more typical college females at a non-elite university? If this math ability tilt is found in a more typical female college population it may enhance and inform the career counseling process to include not only interests, values, and ability, but ability tilt as well.

Research Questions

Research question one: Is there evidence of an ability tilt toward math in the ACT scores of women who have graduated from a midsize, Midwest state university during the time frame 2000-2013 with a major in inorganic sciences, math or engineering?

Research question two: Is there evidence of an absence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in organic science, nursing, or allied health?

Research question three: Will math tilt, number of completed high school math courses and end of college sophomore year GPA significantly predict a major in inorganic sciences, math or engineering for women graduating from a midsize, Midwest state university during the time frame 2000-2013.

Research hypothesis for question one.

H1: There is evidence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in inorganic sciences or engineering using a Chi Square Test of Independence to evaluate.

Research hypothesis for question two.

H2: There is no evidence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in organic science nursing or allied health using a Chi Square Test of Independence to evaluate.

Research hypothesis for question three.

H3: Using a logistical regression analysis math tilt, number of completed high school math courses, and end of college sophomore year GPA will significantly predict a major in inorganic sciences of engineering for women graduating from a midsize, Midwest state university during the time frame 2000-2013.

Definition of Key Terms

Ability tilt. This refers to an individual's slant or leaning toward certain abilities in tests. For instance, an individual could have a slant or leaning toward math and exhibit higher scores in math as compared with other people. The "ability level" predicts the level of achievement while ability pattern (or tilt) predicts the nature of achievement" (Robertson et al., 2010).

Math tilt. A math tilt would be an ability tilt slanting toward math. Math tilt has been defined in different ways according to the study in which it is used. For the purpose of this dissertation, a math tilt will be established if the individual math score is +1SD from the mean math scores for both the inorganic majors and the organic majors.

Nontraditional Career. The U.S. Department of Labor considers a nontraditional occupation to be one in which females make up 25% or less of the total work force (AFSCME, 2002). Examples of nontraditional occupations include, but are not limited to: construction managers, engineering managers, computer software engineers, computer programmers, mechanical engineers, aerospace engineers, fire fighters, logging workers, carpenters, mining machine operators, and civil engineers (Bureau of Labor Statistics, 2011).

Organic science. For the purpose of this study, organic science will include nursing, dental hygiene, health sciences, and biology. Nursing/allied health would include the following programs: dental hygiene, health sciences, biology, and nursing.

Inorganic science. For the purpose of this study inorganic sciences consist of: astronomy, automotive engineering technology, chemistry, civil engineering, computer engineering technology, computer engineering, computer science, construction management, electrical engineering, electrical engineering technology, integrated engineering, manufacturing engineering, software engineering, information systems, general engineering, manufacturing engineering technology, mathematics, mechanical engineering, physics, and statistics.

STEM. STEM is the acronym for Science, Technology, Engineering, and Math.

Summary

In this chapter, a discussion was provided about the lack of women in STEM studies and careers. It focused on the past reason of self-efficacy for this lack (Betz & Fitzgerald 1987; Hackett, 1985), although the research was mixed concerning self-efficacy as the reason women drop out of the STEM pipeline (Lent et al., 1986). In addition, it was suggested that an ability tilt toward math (Webb et al., 2002; Benbow et al., 2000) and balancing family and work (Donaldson, 1995; Eccles, 1994; Nauta et al., 1998) were reasons women dropped out of the STEM pipeline. This chapter was concluded with the theoretical framework used – The Theory of Work Adjustment - to guide the paper and identified a gap in the literature of how an ability tilt affects college major and career choice, along with the purpose of this paper. In chapter two a review of the literature is provided that is relevant to this research: self-efficacy, lifestyle preference, ability, and ability tilt.

CHAPTER TWO

REVIEW OF THE LITERATURE

Introduction

The Civil Rights Act of 1964 enabled women to pursue occupations that had been denied to them because of discrimination based on sex. Since the 1960s career development researchers have focused on the career needs of women, helping women to realize their career potential (Farmer, 1997). Despite this focus, in 1997, only 5.7% of all women in the workforce were employed in occupations considered nontraditional for females (AFSCME, 2002). The U.S. Department of Labor considers a nontraditional occupation to be one in which females make up 25% or less of the total work force (AFSCME, 2002). Examples of nontraditional occupations include, but are not limited to: construction managers, engineering managers, computer software engineers, computer programmers, mechanical engineers, aerospace engineers, fire fighters, logging workers, carpenters, mining machine operators, and civil engineers (Bureau of Labor Statistics, 2011). Traditional female careers are thought of as those in which women make up 95% or more of the work force (Chatterjee & McCarrey, 1989). However, other research has suggested that traditional occupations are those where women make up 85% or more of the work force (Whiston, 1993). Examples of traditional occupations for women include, but are not limited to preschool and kindergarten teachers, speech-language pathologists, dental hygienists, dental assistants, childcare workers, secretaries, and administrative assistants (Bureau of Labor Statistics, 2011).

The National Employment for Women Act mandated that states develop goals for the training and placement of women in nontraditional jobs (U.S. Department of Labor, 2004). This focus was partially based on advantages of working in characteristically nontraditional jobs. Two significant advantages of work in nontraditional jobs for women included better benefits and better pay. Data compiled in 2002 indicated that salaries for nontraditional occupations were reported to be 20% to 30% more than for traditional female jobs (AFSCME, 2008). Occupations in the trades and technical fields also often offer better health benefits and sick leave time than traditionally female occupations (AFSCME, 2008).

For the past 20 years, nontraditional careers have been more open to women, however, men and women continue to enter jobs and educational programs based on perceived sex appropriateness (Betz & Hackett, 1981; Eccles, 1994; Evetts, 1993; Gottfredson, 1981; Whiston, 1993). Thus, women have continued to not only be under represented in many occupations, particularly careers in science, technology, engineering, and math (STEM), but they also have continued to be over represented in low pay and low status occupations (Betz & Fitzgerald, 1987; Sheye &

Gilroy, 1994) with few opportunities for advancement (Betz & Fitzgerald, 1987), thus demonstrating a gender gap. While the gender gap is closing in some fields such as law and biology (Lubinski, Benbow, Shea, Eftekhari-Sanjani, & Halvorson, 2001), when women choose a profession in a science related field, it often tends to be a lower prestige career than careers that men choose. For instance, women tend to choose careers in the helping sciences like nursing and health technicians (Farmer, 1997). In contrast, men choose science careers in engineering or "at the physician level within the health fields…" (Farmer, 1997, p. 386). Women who possess math and science abilities tend to pursue organic sciences, such as biology or health sciences, and humanities while men who possess math and science abilities tend to pursue engineering and physical science, such as chemistry or physics (Lubinski, Benbow et al., 2001). Even when women aspire to nontraditional STEM-based occupations they tend to leave the field, known in the literature as dropping out of the pipeline (Mau, 1995; Subotnik & Steiner, 1994). In a longitudinal study, 83% of women aspiring to a nontraditional occupation in twelfth grade were no longer in the pipeline seven years later (Frome et al., 2006). Although the nontraditional careers in this study were not limited to STEM, such nontraditional careers as engineers and chemists were included.

Research findings also indicated that there are fewer U. S. mathematicians and engineers being developed by the American educational system (Adair, 1991). It has been noted that students in other countries exhibit greater science achievement as compared to students in the United States (Stake & Nickens, 2005). In the United States, six percent of bachelor's degrees conferred in engineering are to "nonresident aliens" (Digest of Education Statistics, 2010). That percentage rises exponentially with masters and doctoral degrees in engineering. Nonresident aliens comprised 43% of the master's degrees conferred and 58% of doctoral degrees conferred in U. S. higher education institutions (Digest of Education Statistics, 2010). In addition, the research indicated that there is a significant gap between males and females enrolled in these programs (Lubinski, Benbow et al., 2001). Recruiting and assisting females to persist in STEM programs will decrease the gender gap in STEM programs and occupations. Furthermore, it will likely increase the number of scientists, mathematicians, and engineers being produced in the U.S. educational systems. There have been attempts to explain reasons for this gender gap in STEM programs. Three rationales for this gap have included self-efficacy theory, life style preferences, and math tilt. This paper reported the research in these three areas.

Rationale for STEM Imbalance between Men and Women

Self-efficacy

Historically, hypotheses concerning reasons women may not consider STEM careers have been linked to self-efficacy (Betz & Fitzgerald 1987; Hackett, 1985; Lent, Lopez & Bieschke, 1991; Lindley, 2006; Mau, 2003; Lopez & Lent, 1992; Nevill & Schlecker, 1988; Nauta et al., 1998; Pajares & Miller, 1995; Schaefers et al., 1997; Scheye & Gilroy, 1994; Whiston, 1993). Self-efficacy, or self-efficacy expectations, have been defined as beliefs about one's performance capabilities (Lent et al., 1991). Self-efficacy has been found to mediate a belief that an individual can perform behaviors or tasks necessary for certain outcomes (Bandura, 1977; Betz 2004) and how well one can accomplish behaviors or tasks (Lent et al., 1991). Self-efficacy also been shown to determine how much effort will be expended and how persistent the individual will be in pursuing a given task. (Bandura, 1977). While self-efficacy is not a measure of an individual's skills, self-efficacy has been shown to determine the perception of skills, the number of skills and what can be accomplished or done with those skills (Bandura, 1977).

There are four sources of efficacy expectations: performance accomplishments, vicarious learning or modeling, verbal persuasion or encouragement, and emotional arousal or anxiety (Bandura, 1977, 1997; Betz, 2004). These self-efficacy sources originate in one's family or origin (Betz, 2004). Of these four sources, performance accomplishments of the individual are the most influential source of efficacy information (Bandura, 1997; Hackett, 1985; Lent et al., 1991; Lopez & Lent, 1992).

Past performances are what Bandura (1997) referred to as "enactive mastery experiences that serve as indicators of capability" (p. 79). Thus, successful performances increase self-efficacy, and repeated performance failures lower self-efficacy (Bandura, 1997). Math is the gateway to science careers (Lindley, 2006), acting as a critical filter in career choice (Lopez & Lent, 1992). Math self-efficacy mediates math; therefore, tends to influence the choice of science careers (Lindley, 2006). Consequently, for women entering STEM careers this would suggest that their past performances in math or math-related courses would affect their self-efficacy regarding math and thus affect choice of STEM majors. Because math self-efficacy is influenced by past math performance, it has been suggested that the more math courses a woman has taken the greater the math achievement and the greater her math self-efficacy (Hackett, 1985).

In a study of 117 college students (72 females and 45 males) enrolled in an introductory psychology class, it was found that the variables of ACT mathematics score, math anxiety, and years of high school math taken were highly correlated to the choice of a math-related major (Hackett, 1985). These students indicated a diverse span of academic majors. To ascertain if math self-efficacy was related to the choice of a math major, four assessments were used: *Math Self-Efficacy Scale (MSES), Fennema-Sherman Mathematics Attitude Scales, Bem Sex Role Inventory* (BSRI), and a background questionnaire. The *Fennema-Sherman Mathematics Attitude Scale* is comprised of nine subscales. Initially, Hackett (1985), used only five of the nine subscales as part of the assessment. Although five subtests were administered, only the Math Anxiety subscale was used in the study. Subsequently, for her study only the Math Anxiety scale was used. The rationale for using only this subscale was based on previous research that demonstrated that only the Math Anxiety subscale was a factor in the selection of a math or math-related major (Hackett, 1985).

The BSRI masculinity scale was used to measure sex role socialization. It was hypothesized that gender would influence all other variables; gender would influence the number of years the participants enrolled in high school math courses, previous math achievement, math anxiety, and confidence in learning math (Hackett, 1985). The background questionnaire gathered demographic information, mathematics preparation information, and career plans. The college majors were rated as to their math relatedness on a continuum from fine arts (1) to mathematics and physical science (5). All the variables, except for the masculinity score, correlated with the choice of a college major. Thus, math ACT scores, and years of high school math, and math anxiety correlated with math self-efficacy (r = .66, .58, and .47 respectively). In this study, Hackett (1985) reported that self-efficacy had the highest correlation to the choice of a math related major ($r = .50$, $p < .001$). Although gender did not directly affect math self-efficacy, "males tended to score higher on the BSRI masculinity scale and that higher masculinity scores were related to higher levels of math self-efficacy" (Hackett, 1985, p. 51). In other words, there appeared to be a relationship between masculinity scores on the BSRI and math self-efficacy.

However, gender alone has not explained math related behaviors prior to college. In Hackett's study the masculinity score of the BSRI predicted neither years of high school math courses nor ACT math scores. Results indicated that the more math courses taken, the greater the math achievement, and greater math self-efficacy (Hackett, 1985). These findings supported Bandura's premise that past performance has the most impact on the development of self-efficacy (Bandura, 1997).

Consideration as to the rationale for only using the masculinity scale of the BSRI in this investigation is warranted. Perhaps, had the author chosen to utilize the entire BSRI scale a more complete picture concerning gender as a variable would have been provided. It might be that a more egalitarian view of gender roles, as opposed to masculine views of gender roles, may be more predictive of math behaviors in high school and math ACT scores for females. Corrigal and Konrad (2007) secured follow-up data from *Monitoring the Future Study* involving 3452 high school seniors from 1976 through 1990. Of the 3,452 students, 1,875 were female. Gender role attitudes were obtained, and based on the responses gender role attitudes were ascertained to be traditional or egalitarian. Although this study (Corrigal & Konrad, 2007) attempted to determine correlations between gender role attitudes and hours worked per week, hourly or weekly pay, marital status, children, and Bachelor's Degree, it was established that "women with more egalitarian attitudes take actions that differ from those of women with more traditional attitudes" (p. 853). This suggested that women who hold more egalitarian attitudes will not be as constrained by traditional gender roles when choosing careers.

Past performance was also the most influential factor on math self-efficacy and was reported in a study of high school students (Lopez & Lent, 1992). The four primary sources of efficacy information (past performance accomplishments, vicarious learning, verbal persuasion, and emotional arousal) and math self-efficacy were considered to ascertain their relationship to high school students' self-efficacy. Fifty students (19 males and 31 females) participated in this study. All participants were considered to possess advanced math skills because they were enrolled in Algebra II. Algebra II was considered an advanced math class in this particular high school because it was beyond the two required math classes needed for graduation. The participants were mostly high school juniors (84%), with a mean age of 16.42 (SD = .54). The participants had a mean GPA of 2.68 (SD = .53). Approximately half the participants (26, or 52%) anticipated going to a four-year college after graduating from high school (Lopez & Lent, 1992).

Four measurements were used to determine sources of efficacy information and its impact on math self-efficacy (Lopez & Lent, 1992). *The Sources of Math Efficacy Scale* (SMES) was used to tap the four sources of efficacy information, past performance accomplishments, vicarious learning, verbal persuasion and emotional arousal. Only minor changes were made to adapt the SMES for use with high school students. The *Math Self-Efficacy Scale* (SE) utilized math problems selected by the course instructor for use. This math scale measured knowledge of mathematics presented in the past semester of the school year and possible future math problems. The *Academic Self-Concept Scale* assessed global academic self-confidence. A self-report instrument, *Math/Science Interest*, ascertained a student's interest in math and science. This assessment included items adapted from the Activities section of Holland's Self-Directed Search. The fourth instrument used was the *Usefulness of Mathematics Scale*. This scale probed students' perceptions concerning the usefulness of mathematics in their plans for the future and in their work (Lopez & Lent, 1992).

The results of this study (Lopez & Lent, 1992) supported Bandura's (1997) premise that past performance is the most influential source of efficacy information. Past performance (i.e., grades) and perceived accomplishments (i.e., "I have received special awards for my math ability") were the most influential factors on math self-efficacy. Supporting Bandura's (1997) claim that efficacy information must be related to a specific task, Lopez and Lent (1992) found that academic self-concept, a global measure of self-confidence, was unable to explain a distinctive variance in math self-efficacy. Therefore, it was suggested that domain specific self-efficacy is more influential on math self-efficacy than global academic self-confidence. Global academic self-confidence did not contribute to math self-efficacy (Lopez & Lent, 1992). However, past performance alone is not necessarily the only factor in establishing math self-efficacy. Other factors that might influence math self-efficacy are frequently weighed in by the individual. These factors might include difficulty of the task, amount of effort required, amount of external influences, and the circumstances surrounding the task (Bandura, 1997).

Vicarious experiences - observing others perform similar tasks - is the second source of self-efficacy (Bandura, 1977, 1997). This second source of vicarious experience is less valuable than one's own performance accomplishments (Bandura, 1977). Bandura indicated that when modeling acts as a source of self-efficacy, the individual must make inferences about his or her observations. Based on these inferences, the individual comes to conclusions about comparisons between himself or herself and the model (Bandura, 1977). Thus, the information from this source is weaker than knowledge about personal past performances (Bandura, 1977). However, if an individual lacks adequate personal experience, modeling plays an important role in the development of self-efficacy (Bandura, 1997). Seeing others achieve, who are similar to one's self, can increase self-efficacy (Bandura, 1997).

Nevertheless, vicarious learning was not found to add to the variance in math self-efficacy as measured by the *Math Self-Efficacy Scale* when studying high school students and sources of efficacy (Lopez & Lent, 1992). Perhaps a reason for this is because modeling that does not have clear outcomes does not convey as much efficacy information as modeling with clear outcomes (Bandura, 1977). It should also be noted that Bandura's hypotheses regarding modeling as a source of efficacy information was related to treatment outcomes in working with people with phobia disorders (Bandura, 1977). Vicarious learning as a source of math self-efficacy may be more ambiguous than outcomes in phobia treatment.

While there is minimal data on vicarious learning as a source of math self-efficacy specifically, there are data that support the importance of role models for women entering STEM studies (Anderson & Gilbride, 2007;

Fouad et al., 2010; Nauta et al., 1998). While it is not clear how role models specifically influence a female, it has been hypothesized that role models can influence career development by being a source of self-efficacy and demonstrating how role conflicts can be resolved (Nauta et al., 1998). Role conflict can occur when the demands of work and the needs of family are incompatible (Nauta et al., 1998). Females in middle school through college indicated that not knowing adults with successful careers in STEM fields was a significant barrier for these females entering math or science based careers (Fouad et al., 2010). Role models can be seen as a means for support for women interested in STEM careers (Fouad et. al., 2010). However, at times it is difficult to discern from the literature if the role models actually function as role models or as a source of encouragement.

Participants in the study conducted by Fouad and colleagues (2010) included males and females from the Southwest and Midwest regions of the United States. The participants from the Southwest were all females. The study consisted of middle school students (26 females and 5 males), high school students (34 females and 4 males), and college students (39 females and 5 males). The purpose of the study was to examine supports and barriers related to pursuing a STEM career (Fouad et al., 2010). A literature review produced 75 possible barriers and supports affecting students pursuing a STEM career. These 75 barriers and supports were reduced to five general categories: family influences, school influences, financial and environmental influences, social influences, and internal influences. Environmental influences included perceptions of gender roles and opportunities for extracurricular activities. Internal influences included interest in math and science, and the individual's perception of how much difficulty he or she will encounter in math and science (Fouad et al., 2010).

Within each of the general categories possible supports or barriers were included (Fouad et al., 2010). Participants were asked to assess the degree of influence each of the support or barrier had on them based on a Likert-type scale (1 = "Very little influence" to 5 =" Very strong influence"). No significant gender differences were found about the number of supports or barriers perceived. However, educational level, whether middle school, high school, or college, produced differences in the number of supports and barriers perceived. Considering the lack of gender differences, one must be concerned about the number of male participants; noting that there are more than six times as many female as male participants. Because of this rather small number of males, results regarding gender differences or similarities must be viewed with caution.

The findings in this study (Fouad et al., 2010), suggested that friends (possible encouragers) and adults (possible role models and encouragers) were important for high school girls. Females reported that not knowing adults with successful STEM related careers was considered a significant barrier ($p \leq .001$). Teachers were seen as both a support and a barrier by females at all three levels, middle school, high school, and college. Thus, teachers could be seen as expecting a female student to do well and encouraging her (i.e., support). On the other hand, teachers could be barriers by a "lack of inspiration" and withholding advice to female students. In addition, the gender of the teacher was seen as a barrier for females (Fouad et al., 2010).

Another study (Nauta et al., 1998) also suggested that role models may contribute to enabling women to perceive how to manage multiple roles. These role models also allow women to develop self-efficacy in managing multiple roles. This study postulated that role models had more impact on women majoring in math, engineering, and the physical sciences than women in the biological sciences. Females who had role models in the STEM careers are more inclined to see the possibility of math, science, and engineering careers being compatible with marriage and family (Nauta et al., 1998). It has been suggested that for female high school students, female role models provided the greater influence (Anderson & Gilbride, 2007).

Although Nauta and colleagues (1998) examined higher career aspirations among female undergraduate students, the study examined the construct of self-efficacy and role models as related to higher level career aspirations. Higher level career aspirations refer to a desire for leadership or advancement in a career. While the concept of higher career aspirations seems to be a step beyond importance of role models in choosing a STEM career, it does validate the importance of role models to females entering the STEM studies for self-efficacy in career choice. The participants in this study (Nauta et al., 1998) were female undergraduate students majoring in math, science, or engineering at a large Midwestern university. Students were categorized into two groups. One group consisted of women enrolled in math, physical science, and engineering (n = 335). The typical majors for women in this group included "math, all types of engineering, computer science, statistics, biochemistry, geology, physics, and chemistry" (Nauta et al. 1998, p. 485). The second group was comprised of women majoring in biological science (n = 211). Typical majors for the women in the second group were "animal science, dietary science, agricultural studies, microbiology, botany, pre-veterinary medicine, biology, zoology, horticulture, pre-health professional studies, and genetics" (Nauta et al., 1998, p. 486).

The ability of the women in this study was measured by scores from their ACT Assessment Test, and Scholastic Assessment Test, as well as their cumulative college grade point averages (Nauta et al., 1998). Self-efficacy was measured by using the *Self-Efficacy for Academic Milestones Scale*. This scale assesses a student's belief in his or her ability to accomplish specific tasks needed for success in most science, engineering and math majors. The influence of role models was assessed using the *Influence of Role Model Scale*. When students were asked to assess the influence of a male friend, female friend, father, mother, female teacher and male teacher, it was difficult to determine if the influence was that of a role model or someone who simply gives encouragement.

The women students' beliefs about role conflict were measured by a Likert-type scale to assess the compatibility of science careers with marriage and family responsibilities. Students assessed statements such as, "It is very difficult for a woman to combine a career as a scientist with a family life" (Nauta et al., 1998, p. 487) on a continuum from strongly disagree to strongly agree. The *Career Aspiration Scale* was used to assess the higher-level career aspirations of the participants. An example of a career aspiration assessed was "I plan on developing as an expert in my career field" (Nauta et al., 1998, p. 487). The results indicated a correlation between positive role model influence and self-efficacy. In this investigation, year in school and ability also correlated to self-efficacy. Furthermore, over one-third of the variance in self-efficacy was explained by the three constructs of positive role model influence, year in school, and ability (Nauta et. al., 1998). In addition, positive role model influenced affected role conflict; the more positive the role model the less role conflict perceived.

For women who declared STEM majors, there was a higher correlation between self-efficacy and positive role models than for women who declared biological sciences majors. These results supported Bandura's theory that role models help build self-efficacy. Role models might also be helpful in developing self-efficacy toward STEM careers by allowing women to observe other women reach "specific academic milestones" (Nauta et al., 1998). Thus, women who observe this might believe that they too can reach academic milestones and be successful.

Although Betz and Hackett (1991) reported that women had higher self-efficacy for traditionally female careers and lower self-efficacy for nontraditional careers, there are contradictory data that refute this (Lent, Brown & Larkin, 1984). Forty-two students enrolled in a career planning course were asked to participate in a study about self-efficacy (Lent et al., 1984). This course was designed for students considering science and engineering majors. Of these 42 students, 34 completed the self-efficacy assessments (24 males and 10 females). Self-efficacy measures based on Betz and Hackett (1981) were used to assess participants' beliefs about completing job duties required for science and/or engineering careers (Lent et al., 1984). The results of this study indicated that there were no gender differences in self-efficacy for performing job duties associated with science and/or engineering careers. However, self-efficacy was correlated with math aptitude (PSAT scores) and academic achievement (grades and GPA) (Lent et al., 1984). Thus, while self-efficacy is important in pursuing STEM studies and careers, this research suggested that women who chose STEM studies exhibited high self-efficacy for math or nontraditional careers (Lent et al., 1984).

Overall, the literature suggested that there is a relationship between self-efficacy and choosing a STEM major. However, self-efficacy alone does not predict educational major or career choice.

Lifestyle Preference

Lifestyle preferences refer to how individuals desire to structure their lives surrounding attitudes of family, career, personal development, community social relationships, and personal development (Robertson et al., 2010). Historically, in the context of lifestyle preferences females more than males have been concerned with balancing family and marriage with a career (Donaldson, 1995; Eccles, 1994; Nauta, Epperson & Kahn, 1998). This lifestyle preference of females' concern with family and career balance continues into the 21st century (Coltrain, 2000; Corrigal, & Konrad, 2007; Fox et al., 2006; Frome et al., 2006). The research suggested that female career choice has been frequently mediated by aspirations for marriage, family, and perceptions of household tasks (Coltrain, 2000; Corrigal & Konrad, 2007). As home-family roles become more of a priority, work roles can be compromised (Madill et al., 2000). Women have often expressed the desire for career and family balance in wanting flexible work hours (Frome et al., 2006), part time work, at least for a period of time (Benbow et al., 2000; Ferriman et al., 2009; Heilbronner, 2012; Lubinski, Webb et al., 2001; Roberston et al., 2010), and/or a career that can be combined with a family (Frome et al., 2006). Balancing work and family is one reason given for females leaving educational studies in STEM or careers in science related fields (Fox et al. 2006; Frome et al., 2006; Madill et al., 2006). This desire for career and family balance is found not only within STEM careers (Benbow et al. 2000; Ferriman et al., 2009; Heillbronner, 2012; Lubinski, Webb et al., 2001, Lubinski et al., 2006; Robertson et al., 2010), but also in other nontraditional occupations as well (Coltrain, 2000; Frome et al., 2006; Madill, 2000). Therefore, for many career oriented women, part-time work is an important component (Hallett & Gilbert, 1997).

During the fall of 1993, researchers conducted a Canadian longitudinal study and began following 156 female eleventh graders who qualified for the summer research program for the *Women in Scholarship, Engineering, Science and Technology* (WISEST). The females were administered the *Values Scale* (VS) and *Salience Inventory* (SI) (Madill et al., 2000). During the winter of 1996, the VS and SI were re-administered. Both instruments consisted of a Likert-type scale to assess values (e.g., Economics, Prestige) and major life roles (e.g., Study, Work, Community

Service, Home/Family, and Leisure). Of the 156 initial participants, 106 completed the last assessment (Madill et al., 2000). Of the initial participants, those who responded in 1996, 113 participants were enrolled in "science-related" fields, 30 in fields such as arts, business, or education and 6 were not involved in any postsecondary education. Home and family were reported as significant values over time (Madill et al., 2000). The study showed that all participants in the initial interview had indicated a career in a science field. However, of the 26% who indicated that medicine was their career goal, 20% were actually pursuing a career in medicine (Madill et al., 2000). Participants reported that one reason for leaving the medical science pipeline was long hours of work. This reason (long work hours) coupled with the belief that the intensity of the work was not well-suited with home and family life (Madill et al, 2000). Madill and colleagues (2000) suggested that career aspirations may be compromised by the individual's perception of home and family obligations.

This conflict has affected not only females considering a medical career (Madill et al., 2000), but also affects those women who have already attained a career in medical science (Fox et al., 2006). When researching the advancement of women at the University of Illinois College of Medicine (UI-COM), it was found that women sought part-time positions because of child care issues while men sought part-time positions to “moonlight” (Fox et al., 2006). In addition, the primary reason for a tenure rollback request was parenthood and/or childcare (Fox et al., 2006). Another term for tenure rollback is “stop the clock.” A tenure rollback takes place when an employee requests that the clock be stopped for the time frame in which requirements for tenure take place. At UI-COM parenting and/or childcare was the primary reason for women faculty to request a tenure rollback. Conversely, there were no requests from men stating childcare as the reason for the request (Fox et al., 2006).

The attitude that female careers in science are not compatible with family life was supported in a study tracking women from age 18 years to age 25 (Frome et al., 2006). Females reported that they would choose traditional female careers because they appear to be more flexible in regard to family responsibilities (Frome et al., 2006). For participants in the SMPY (Study of Math Precocious Youth) longitudinal study, females stated that part time work and/or flexible work schedule were important to them (Benbow et al., 2000; Ferriman et al., 2009; Lubinski, Webb et al., 2001; Lubinski et al., 2006; Webb et al., 2002).

In 1971, Julian C. Stanley, of John Hopkins University, initiated a study of mathematically gifted youth (Lubinski, Webb et al., 2001), known as the Study of Mathematically Precocious Youth (SMPY). The SMPY is a longitudinal study designed to track the profoundly gifted over a 50-year period. The first cohort was identified between 1972 and 1974, (Lubinski &

Benbow, 1994; Lubinski, Benbow et al., 2001). There were four more cohorts acknowledged at differing intervals, with the last, Cohort 5 identified between 1991-1992 (Wai, Lubinski, Benbow, & Steiger, 2010). Life values, personal views, and work preferences were obtained from participants of Cohort 5 at intervals of age 25 and 35 years (Ferriman et al., 2009). There were 750 participants in this cohort. Cohort 5 participants were U. S. citizens enrolled in graduate programs in engineering, mathematics, and physical science studies at eminent universities. The universities covered various geographical regions of the United States. These universities included, but were not limited to, California Institute of Technology, Cornell University, Harvard University, John Hopkins University, Massachusetts Institute of Technology, Northwestern University, Stanford University, University of California – Berkeley, University of Illinois, University of Washington, University of Michigan, and University of Wisconsin (Lubinski, Benbow, et al., 2001).

During the 10-year period there was little difference noted between males and females on work preferences of "receiving a good retirement package, respecting colleagues" and being able to use "complex or high level skills at work" (Ferriman et al., 2009, p. 520). Over this 10-year period, the importance of being able to have flexibility in their work schedule and limiting their work hours increased for women but not for men (Ferriman et al., 2009). At age 35 gender differences were noted for being able to have a flexible work schedule, limited work hours, and being free on the weekends. Ten years earlier these gender differences were not present. During their mid-twenties, Cohort 5 women placed the same importance on these variables as men. However, after motherhood, more importance was placed on these factors (Ferriman et al. 2009). In Cohort 5, 40% of the women with children reported that a part-time career was important. Conversely, only 15% of the men with children reported that a part-time career was important (Ferriman et al., 2009). The reports of the Cohort 5 participants suggested that women with children placed more value on part-time work than men with children. As stated earlier, balancing career and family appears to impact female career choice more than male career choice.

Studies of other cohorts in the SMPY suggested similar results to values and life preferences as Cohort 5. Females in Cohort 3 also indicated the importance of part-time work (Lubinski, Webb et al., 2001). The participants of Cohort 3 were identified between 1980 and 1983. There were 501 participants in this cohort with SAT-M ≥ 700 or SAT-V ≥ 630 before 13 years of age (Lubinski & Benbow, 1994; Wai et al., 2010). These participants were recruited by using talent searches from across the United States (Achter, Lubinski, Benbow & Eftekhari-Sanjani, 1999). While there were many similarities between males and females regarding lifestyle preferences, there were some notable differences. A survey of

Cohort 3 of lifestyle preference (Lubinski, Webb et al., 2001) indicated the most notable gender differences occurred involving a part time career (Effect Sizes = .50 and .46). Women considered a part-time career more important than men did. In addition, another gender difference in lifestyle preferences was found. Significantly more men considered making "lots of money" more important than women did (Lubinski, Webb et al., 2001). Based on the SMPY longitudinal study, profoundly gifted males and females have similar lifestyle preferences with differences in "making lots of money" and balancing a career and family.

The SMPY cohorts 1, 2, 3, and 5 were surveyed in their mid-thirties to ascertain the number of hours currently worked and the number of hours participants were willing to work at an ideal job (Lubinski et al., 2006; Robertson et al., 2010). By this time participants were becoming - if not already - established in their careers. Participants in this survey consisted of 1,694 males and 999 females (Robertson et al., 2010). Although in the article the researchers did not specify the number of women working less than 40 hours per week, based on a graph it appeared that between 25% and 30% of females in Cohorts 1, 2, and 3 worked less than 40 hours per week. Approximately 12% to 16% of Cohort 5 females worked less than 40 hours per week. Only 10% or less of the men from Cohorts 1, 2, 3, and 5 worked less than 40 hours per week (Lubinski et al., 2006; Robertson et al., 2010).

As part of the same survey, participants were asked how many hours per week they would be willing to work at an ideal job (Lubinski et al., 2006; Robertson et al., 2010). Similarly, 25% of the women from Cohorts 1, 2, and 3 indicated they would prefer to work less than 40 hours per week. While only 12% to 15% of Cohort 5 women preferred to work less than 40 hours per week. Conversely less than 10% of the men from Cohorts 1, 2, 3 and 5 preferred working less than 40 hours per week (Lubinski et al., 2006; Robertson et al., 2010). Women in all cohorts placed more value on family than their male counterparts (Robertson et al., 2010). Even though these profoundly gifted females placed more importance on family than their male counterparts, the females in Cohorts 3 and 5 had birth rates below the national average and the number of women without children was greater than the general population (Lubinski et al., 2006). Perhaps one means of balancing family with work is to delay motherhood role until later in life or to have fewer children.

Ability Tilt

One way to fulfill the potential of women in STEM is to increase the number of women in the STEM pipeline. It is suggested that the limited opportunities and how women are culturally conditioned are major variables in understanding the gender disparity in STEM studies and careers (Webb et al., 2002). However, more recent research using longitudinal data examined gender differences in abilities and interests of precocious youth. This research suggested that there are no gender differences in general intelligence, but males and females differ in ability patterns (Webb, et al. 2002).

In 1971, Julian C. Stanley, of John Hopkins University, initiated a study of mathematically gifted youth (Lubinski, Webb et al., 2001). This study is known as the Study of Mathematically Precocious Youth (SMPY). The SMPY is a longitudinal study designed to track the profoundly gifted over a 50-year period. The first cohort was identified between 1972 and 1974, (Lubinski & Benbow, 1994; Lubinski, Webb et al., 2001). There were four more cohorts acknowledged at differing intervals, with the last, Cohort 5, identified between 1991-1992 (Wai et al., 2010). Participants were surveyed at critical points in their lives: at ages 13, 18, 23, and 33. Follow up questions at age 18 and 23 generally consisted of educational probes having to do with high school and/or college experiences (Webb et al., 2002). More specifically, 18-year olds were questioned about their high school experiences and their future plans for college. Conversely, 23-year olds were queried concerning their undergraduate college experiences as well as their "achievements, attitudes and personal preferences and their future educational and vocational plans" (Webb et al., 2002). Collecting data at these specific ages enabled researchers to control for developmental changes in the participants and historical influences (Lubinski & Benbow, 1994). Cohort 5 was surveyed only at age 23 because this cohort was not assembled as the others. Cohort 5 comprised graduate students from the mathematical and physical science departments of top U. S. universities (Wai et al., 2010).

The participants in the initial cohorts were chosen from students between 12 and 13 years of age whose score on national standardized tests (e.g., Iowa Tests of Basic Skills) that placed them in the top 3% of students in the nation. A "talent search" was performed to identify these top 3% students and they were invited to take the Scholastic Aptitude Test (SAT). The SAT-Verbal (SAT-V) and the SAT-Math (SAT-M) were administered to these top performing 12-13 year olds (Lubinski & Benbow, 1994; Lubinski, Benbow et al., 2001).

The SAT is an aptitude test that assesses both verbal and math skills of high school juniors and seniors. The purpose of the SAT is to assess the readiness of high school juniors and seniors in pursuing college course work. The SAT test knowledge of reading, writing, and math (http://professionals.collegeboard.com). Those students who were in the top 3%, as identified by the talent search and who accepted the invitation to participate, took the SAT approximately four years before they were scheduled to do so. Normally the SAT is administered to high school juniors or seniors. This "out-of-level testing" (Lubinski & Benbow, 1994) was used to distinguish the profoundly gifted or the top 1% of the U.S. population. If profoundly gifted students were to wait until their junior or senior year of high school to take the SAT, they could not be identified from high ranking gifted students because of a ceiling effect (Lubinski & Benbow, 1994). In other words, the profoundly gifted individual could not be distinguished from the gifted individual because the SAT does not have "enough ceiling to adequately capture the scope of their intellectually capacity" (Wai et al., 2010). Both groups, gifted and profoundly gifted, tend to "pile up at the ceiling" of tests such as college entrance exams (Park, Lubinski, & Benbow, 2007). If these profoundly gifted students were tested with their age peers on the SAT, their performance would consistently be at the ceiling of the test. Thus, the above level testing was indicated in order to obtain a true ceiling (Park et al., 2007; Lubinski, Benbow et al., 2001; Web et al., 2002).

The Cohorts of the SMPY were defined as follows:

Cohort 1: Identified between 1972 and 1974. There were 2,188 participants in this cohort with SAT-M ≥ 390 or SAT-V ≥ 370 before 13 years of age (Lubinski & Benbow, 1994; Wai, et al., 2010) and were students in either seventh or eighth grade (Lubinski & Benbow, 1994). Participants were recruited from the state of Maryland, with many from the Baltimore area (Lubinski & Benbow, 1994).

Cohort 2: Identified between 1976 and 1978. There were 778 participants in this cohort with SAT-M ≥ 500 or SAT-V ≥ 430 before 13 years of age (Lubinski & Benbow, 1994; Wai et al., 2010) and during the seventh grade (Lubinski & Benbow, 1994). These participants were recruited from the Mid-Atlantic States (Lubinski & Benbow, 1994).

Cohort 3: Identified between 1980 and 1983. There were 501 participants in this cohort with SAT-M ≥ 700 or SAT-V ≥ 630 before 13 years of age (Lubinski & Benbow, 1994; Wai et al., 2010). These participants were recruited by using talent searches from across the United States (Achter et al., 1999). Thus, not restricting the participants to the east coast area.

Cohort 4: Identified during the summer of 1987. There were 1,000 participants in this cohort with SAT-M ≥ 500, SAT-V ≥ 430, and a score of at least 20 on the American College Testing (ACT) subtest/composite. During1987 these students were attending Iowa State's summer program for intellectually talented youth. Participants were primarily from the Midwest (Lubinski & Benbow, 1994; Wai et al., 2010), and were identified by the Office of Precollegiate Programs for Talented and Gifted at Iowa State University (Lubinski & Benbow, 1994).

Cohort 5: Identified between 1991 and 1992. There were 750 participants in this cohort. Cohort 5 participants were U. S. citizens enrolled in graduate programs in engineering, mathematics, and physical science studies at eminent universities. These universities covered geographical regions of the United States including, but not limited to, California Institute of Technology, Cornell University, Harvard University, John Hopkins University, Massachusetts Institute of Technology, Northwestern University, Stanford University, University of California – Berkeley, University of Illinois, University of Washington, University of Michigan, and University of Wisconsin (Lubinski, Benbow et al., 2001).

During the process of investigating the data from the various cohorts, an ability tilt was noted (Lubinski & Benbow, 2007; Lubinski. Benbow et al., 2001; Lubinski, Webb et al., 2001; Park, Lubinski, & Benbow, 2007; Webb, et al., 2002). This ability tilt is often defined as at least one standard deviation between the math score and verbal score according to the SAT-V and SAT-M (Lubinski & Benbow, 2007; Lubinski, Benbow et al., 2001). Based on an ability tilt, participants could be grouped according to their SAT scores into three distinct groups. These three groups were the high math group, the high verbal group, and the high flat group (Lubinski & Benbow, 2007; Lubinski, Benbow et al., 2001).

The high math participants exhibited a mean SAT-M score of 729 and a mean SAT-V score of 473. Within this group individuals exhibited a math score of at least one standard deviation above their SAT-V score. Conversely, the high verbal group exhibited a SAT-V score of at least one standard deviation above their SAT-M. The high verbal group presented a SAT-M mean of 556 and a SAT-V mean of 660. The third group was considered to be the high flat group. The high flat group had SAT-M and SAT-V scores within one standard deviation of each other. The high flat group presented SAT-M mean score of 719 and SAT-V mean score of 632 (Lubinski & Benbow, 2007; Lubinski, Benbow et al., 2001).

As noted this tilt pattern was apparent at 13 years of age and influenced the education and career trajectories for these cohort participants (Lubinski & Benbow, 2007). For instance, when considering educational studies, individuals in the high math group tilt group preferred math and science courses. On the other hand, participants in the high verbal tilt group demonstrated a preference for humanities and social sciences (Lubinski & Benbow, 2007; Lubinski, Benbow et al., 2001). It was suggested that there are no gender differences in overall intelligence (Webb et al., 2002), but there are gender differences in specific abilities and/or interest patterns (Benbow et al., 2000; Webb et al., 2002). Cohort 4 participants exhibited no gender difference in verbal ability, as assessed by the SAT-V, but there are pronounced gender differences for the SAT-M (Lubinski & Benbow, 1994). Keeping in mind that all participants demonstrated highly developed mathematic skills, among these mathematically gifted individuals, males performed better on mathematical reasoning abilities. An effect size of approximately .50 favors males in this skill (Lubinski & Benbow, 1994). This gender difference among the mathematically gifted suggests why more males compared to females seek math/science studies. A follow up at age 33 years of Cohorts 1 and 2 supports this assertion (Webb et al., 2002).

Cohorts 1 and 2 were surveyed at age 33 to determine educational degrees obtained. This follow up for Cohorts 1 and 2 was designed to compare those who obtained math and science degrees with those who obtained non-math and non-science degrees (Webb et al., 2002). Based on the SAT scores of these profoundly gifted individuals, all possessed the ability to pursue math and science studies and careers. It should be noted that all participants in Cohorts 1 and 2 attained a SAT-M score of at least 390 at 13 years of age. Based on this score it was determined that these participants represented the top 1% in mathematical reasoning ability (Benbow et al., 2000). In addition, participants' SAT scores at age 13 years met the cut off criteria for entry to some of the most prestigious universities in the United States (Lubinski & Benbow, 1994). The participants in this study were taken from Cohorts 1 and 2, and had indicated at age 18 years that they had intended to pursue math/science undergraduate degrees. These participants consisted of 760 males and 350 females (Webb et al., 2002).

The math and science degree categories of these participants were: engineering, mathematics, biological science, computer science, medical science, physical science, chemistry, earth science, and agricultural science. Of these categories, there were significant gender differences exhibited in five, of which only engineering exhibited an effect size reflecting greater male proportions ($p < .001$); while biological science, medical science, and physical science demonstrated an effect size reflecting greater female participation ($p < .001$) (Webb et al., 2002). An interesting finding was that mathematics reflected greater female participation ($p < .05$), but not as significant as the other categories (Webb et al., 2002). Accordingly, even though certain math and science categories were significantly gender related all participants intended to pursue one of the math and science categories. Even though all participants possessed the ability to complete a math and science degree, only 633 men and 259 women did so. There were 127 men and 91 women who changed their intention of a math or science degree (Webb et al., 2002). The main reason given for opting out of the math and science pipeline was a change of interest (78%). It is interesting to note that when the participants were surveyed at age 33 regarding their career selection, 17% who had received a non-science or non-math degree had reverted to a math or science career (Webb et al., 2002). Some of these careers included but were not limited to management positions, executive positions, lawyers or judges, and medical doctors (Webb et al., 2002). It appears that highly gifted individuals in science and math may not obtain degrees in specific STEM disciplines but may enter careers that rely on STEM skills.

Of those completing math or science degrees, engineering continued to be comprised by a significant number of men ($p < .01$). In addition, the categories of physical science ($p < .01$) and agricultural science ($p < .05$) contained significantly more men than women (Webb, et al., 2002). Only biological and medical sciences contained significantly more women than men ($p < .01$) (Webb et al., 2002). While men had a greater representation in the inorganic sciences (e.g., physics, engineering, or math), women had a greater representation in the organic sciences (e.g., nursing, biology, or physician). Even though there are gender disparities, sex alone did not explain group association. In fact, in this study only 1% of the variance of group inclusion was explained by sex (Webb et al., 2002). The math and science group significantly ($p < .01$) was comprised of more men than women. On the other hand, the non-math and non-science degree group significantly ($p < .01$) was comprised of more women than men (Webb et al., 2002). However, regardless of gender, participants with math tilts pursued mathematics, engineering, and physical science. Accordingly, participants with a verbal tilt pursued the humanities, law and social sciences (Benbow et al., 2000).

In 2001, the SMPY cohort with the highest SAT scores (Cohort 3), was divided into three groups (Lubinski, Benbow et al., 2001). The division was based on the SAT-M and SAT-V scores; high math, high verbal, and high flat profiles distinguished the three groups. Consequently, in other studies using this same data set, other Cohorts were also divided into these three groups (Webb et al., 2002). Those participants with high math scores relative to their verbal scores were considered in the high math group. The high verbal group consisted of participants with high verbal scores in relation to their math scores. These scores were tilted by more than one standard deviation from each other. The high math group exhibited math scores that were tilted more than one standard deviation from the verbal score. The high verbal group exhibited verbal scores more than one standard deviation from their math scores. The high flat group was composed of individuals whose SAT-M and SAT-V fell within one standard deviation of each other (Webb et al., 2002).

The gender make-up of each group was as follows: high math participants (169 male, 16 female), high verbal participants (31 male, 42 female), and high flat participants (53 male, 9 female). It was discovered that 69% of the high math group participants pursued math or inorganic undergraduate science degrees. Whereas only 29% of the high verbal group participants, and 58% of the high flat participants pursed math or inorganic undergraduate science degrees. Of the high math participants, males tended to pursue math or inorganic sciences, while females were split between math and/or inorganic sciences and medicine and/or organic sciences. The gender differences continued to be found within the high verbal group. In the high verbal group men were spilt among math and/or inorganic sciences and humanities and/or arts, while high verbal females mostly gravitated toward humanities/arts (Lubinski, Webb et al. 2001). It is important to remember that all participants exhibited high scores on the SAT-M when they were administered at 13 years of age, thus demonstrating the ability of any participant to pursue a STEM pathway (Webb et al., 2002). However, as noted, an ability tilt appeared to have influence an individual's career trajectory.

Cohorts 1 and 2 were tracked for ability and preference patterns (Webb et al., 2002). It was suggested that regardless of sex, those participants whose scores were tilted toward math (more than one standard deviation above their SAT-V) were more likely to pursue science or math degrees than those individuals exhibiting a high flat profile, even though there was little difference in the mean SAT-M scores of each group (Lubinski, Webb et al., 2001). Regarding gender differences, it was noted that male participants presented more high math tilted profiles than did the female participants. However, the research suggested that it was ability and preference patterns that guided career choice, not gender (Webb et al., 2002).

Comparisons made between Cohort 2 and Cohort 5 suggested significant differences between the graduate students (Cohort 5) and the talent search participants (Cohort 2). Cohort 5 consisted of 368 men and 346 women enrolled in math and science programs at some of the most eminent U. S. universities. The SMPY participants were similar in age to the graduate students, but had been identified around 13 years of age between 1976 and 1979. It was suggested that these SMPY participants were the in the top .5% of the general population in general intellectual ability (Lubinski, Benbow et al., 2001).

The graduate students in the Cohort 5 study demonstrated high intellectual ability based on their SAT scores. Men graduate students had a mean SAT-M score of 718 and a SAT-V mean of 625. Women graduate students had a mean SAT-M score of 701 and a SAT-V mean score of 622. These graduate students' abilities could not be fully assessed because of ceiling effects of the SAT. The validity of scores becomes problematic as the scores approach the maximum possible score. In this case, the maximum possible score is 800 for both the SAT-M and the SAT-V (Lubinski, Benbow et al., 2001). The maximum mean differences between the SAT-M and SAT-V were reported during the 1980s decade as 66 points for men and 33 points for women (College Entrance Board, 1992, as cited in Lubinski, Benbow et al., 2001). Men graduate students had a mean difference between their SAT-M and SAT-V scores of 92 points; women had a mean difference of 79 points.

In comparison to the graduate students, Cohort 2 males revealed a mean difference of 87 points. Conversely, Cohort 2 females revealed a mean difference of only 31 points (Lubinski, Benbow et al., 2001).

Consequently, a math tilt was evident for both male and female graduate students. Cohort 2 male participants also displayed a math tilt but Cohort 2 female participants did not. Another way of viewing this is that 75% of Cohort 2 male participants and 51% of the Cohort 2 females who demonstrated similar mean differences between SAT-M and SAT-V scores (i.e., a math tilt) obtained science and/or math degrees (Lubinski, Benbow et al., 2001). Even though the Cohort 2 females demonstrated mathematical giftedness, they tended to have a flat or balanced SAT profile. In other words, their scores, though higher than the typical student, did not reveal a math tilt.

Women graduate students in Cohort 5 had a mean SAT-M score of 701 (SD=64) and a mean SAT-V score of 622 (SD=94). By contrast, female Cohort 2 participants exhibited a mean SAT-M score of 705 (SD=58), and a SAT-V score of 647 (SD=67). Perhaps this helps to explain why females who possess math and science abilities tend to pursue organic sciences and humanities, while math and science gifted males pursue engineering and physical sciences. Based on the data from Cohorts 2 and 5, those individuals, regardless of gender, who pursued inorganic sciences and engineering exhibited a math tilt when their SAT-M and SAT-V scores were compared.

Follow up studies for Cohorts 1, 2, and 3 were performed at 10-year (Achter et al., 1999) and 20-year (Park et al., 2007) intervals from the time they were first identified. The purpose of the 10-year interval study was to predict educational choice (Achter et al., 1999). Requirements for inclusion in the 10-year follow-up study were having completed the SAT, the Study of Values (SOV), and a college major (Achter et al., 1999). It should be noted that not all the SMPY participants had completed the SOV. Of the 2,188 participants in Cohort 1, only 197 met the criteria for this study. In Cohort 2, 160 of 778 participants met criteria and in Cohort 3, 75 of 423 met criteria (Achter et al., 1999). Thus, a total of 432 participants met the criteria and responded to the follow-up questionnaire. The 10-year follow-up study involved predicting educational track based on the participants' SAT scores and SOV scores (Achter et al., 1999).

The SOV is a values measurement based on motives or interests. The SOV included the following themes: theoretical, economic, aesthetic, social, political, and religious. The political theme was omitted for the purpose of this study (Achter et al., 1999). It was stated that only the five themes selected provided "unique information statistically" (Achter et al., 1999, pg. 780). In addition, Achter and colleagues (1999) reported that there was no difference in the total variance explained by the SOV irrespective of which five of the six themes were used. Consequently, the political theme was excluded because it was proposed that this theme had the least to offer when distinguishing between the math-science and humanities groups (Achter et al., 1999).

The purpose of the 20-year interval study was to predict the area of accomplishment based on ability level and ability tilt (Park et al. 2007). The 20- year interval included those participants who had achieved: (a) degree, either bachelors or masters in either STEM or humanities, (b) PhD in STEM or humanities, (c) college tenure-track in STEM or humanities, and/or (d) patents in the STEM category or literary publications in the humanities category (Park et al., 2007).

The results of both studies suggested that an ability tilt or preference was helpful in predicting educational choice (Achter et al., 1999) and area of accomplishment (Park et al., 2007). However, the 10-year interval study suggested that ability plus values was a better predictor of educational choice than ability preference alone (Achter et al., 1999). More specifically, the 10-year interval study suggested that ability plus values was a better predictor of STEM majors than humanity majors (Achter et al., 1999). However, it should be noted that the small sample size of the humanities majors (n=67) versus the STEM sample size (n=227) may have contributed to this outcome (Achter et al. 1999). Conversely, the sample size in the 20-year interval study was larger for both the STEM group and the humanities group (STEM n = 518; humanities n = 136). The 20-year interval study suggested that there was no difference between the STEM group and the humanities group in ability. On the other hand, a *t*-test indicated a significant difference between the STEM and humanities groups in regard to an ability tilt (p_{rep}>.99) (Park et al., 2007). Therefore, there was a math ability tilt for the STEM group and a verbal ability tilt for the humanities group.

One difficulty in both the 10-year interval study and the 20-year interval study was a lack of a clear definition of an ability tilt. In other studies ability tilt was specifically defined (Lubinski, Webb et al., 2001; Webb et al., 2000). The authors of the 10-year interval study merely allude to an “ability preference” (Achter et al., 1999). The 20-year interval study is minimally clearer by reporting how an ability tilt was established. Park and colleagues (2007) determined an ability tilt by subtracting the SAT-V score from the SAT-M score. If the remainder was positive, then a math tilt was established; if the remainder was negative, then a verbal tilt was determined.

In other studies, an ability tilt was explained as a SAT-M or SAT-V score with one or more standard deviation difference (Lubinski, Webb et al., 2001; Webb et al., 2002). In other words, a participant who presented a math score of more than one standard deviation above his or her verbal score would demonstrate a math tilt. The participant who presented a verbal score more than one standard deviation above his or her math score, would demonstrate a verbal tilt. Authors of other studies utilized the flat profile in their data base (Lubinski, Benbow et al., 2001; Webb et al., 2002). In those studies, the participants who did not exhibit an ability tilt were categorized as having a flat profile, rather than a tilted profile. Based on this criterion of tilt the only instance where an individual could generate a flat or balanced profile would be to have the exact same SAT-M and SAT-V score. In addition, on any given day the SAT-M or SAT-V score could vary at least one point, which would affect the ability tilt.

Both studies (Achter et al., 1999; Park et al., 2007) included in the STEM category mathematics, computer science, physical sciences and engineering. Both studies included in the humanities category art, history, literature, languages, and drama. The 20-year study (Park et al., 2007) stated that "related fields" are included in the humanities category. However, the 20-year study did not define what was meant by "related fields" (Park et al., 2007). The 10-year interval study specifically stated the college majors in both STEM and humanity categories (Achter et al., 1999). The 10-year interval study used the term ability preference, but is vague in how it was obtained (Achter et al., 1999). Although the 20-year study used the term "ability tilt" the way in which it was obtained is different from past definitions. The 10- year interval study refers to an "ability preference", which is not clearly defined. Thus, it is apparent that the term "ability tilt" or "math tilt" is defined differently depending on the research. One thing the definitions have in common is an assessment that the individual demonstrated a higher ability, as measured by the SAT, in either math or verbal areas. Therefore, it appears that the researcher/s defined how an ability tilt will be measured, thereby constituting the definition of an ability tilt.

While extending the research of the 10-year interval study of Cohorts 1, 2, and 3, it was suggested that the SAT and SOV could be used to not only predict college course preference, but also could be utilized to predict career choice as well (Wai, Lubinski, & Benbow, 2005). A 20-year interval follow-up study questioned if preference assessment (e.g., SOV), SAT-M and SAT-V could predict not only educational choice (Achter et al., 1999), but career paths of the SMPY participants as well (Wai et al., 2005). It was reported that the ability preference found at 13 years of age in this population of profoundly gifted youth not only predicted college course preference (Achter et al., 1999), but career preference as well (Wai et al., 2005).

In this 20 -year follow-up study (Wai et al., 2005), 511 participants from Cohorts 1, 2, and 3 met criteria and answered the follow-up questionnaire. As in the Achter et al. (1999) study, the participants had been assessed by age 13, using the SAT-M, SAT-V, and SOV. The 20 -year follow-up study suggested that participants who secured occupations in STEM fields exhibited high SAT-M and SOV-Theoretical scores. Conversely, participants who secured humanities occupations exhibited high SAT-V and SOV-Aesthetic scores.

Based on these studies with this population of the profoundly gifted as demonstrated in the SMPY participants, it appeared that ability preference (or ability tilt) influenced the educational and career trajectories of this sample. Thus, when individuals exhibit extremely high SAT scores and could potentially enter a STEM field, individuals continued to be effected by an ability tilt. Accordingly, an ability tilt in math as demonstrated by SAT-M score, influenced an individual toward a STEM education and career path, while individuals with an ability tilt toward the SAT-V tended to be influenced toward a humanities educational and career track.

This ability tilt has also been found in another data set. In 1942, the Westinghouse Corporation instituted the Science Talent Search (STS) competition (Heilbronner, 2011). Since 1998, the Intel Corporation has become the corporate sponsor, and is now referred to as the Intel Science Talent Search. The competition is designed to support talented high school seniors who demonstrate abilities in STEM studies. A total of 40 semifinalists and 10 finalists are selected each year based on the students' research in a STEM field. The student, along with an adult engaged in some area of STEM, together conduct a research study. The student writes a summary of the research findings and submits it to the Science Talent Search committee for review (Heilbronner, 2011). The participants in this study consisted of finalists and semifinalists from years 1987 to 1989.

This first group composed Cohort 1. The second cohort was comprised of finalists and semifinalists from 1997 to 1999 (Heilbronner, 2011). Members of Cohort 1 were approximately 39 years of age at the time of the study. Members of Cohort 2 were approximately 29 years of age at the time of the study. A total of 1800 men and women – approximately 59% and 41% respectively - were participants in the study (Heilbronner, 2011).

All participants demonstrated high ability levels of math as indicated by their high scores on the SAT-M. The mean SAT-M score for all participants was 729.67 (SD=60.19). This SAT-M mean was significantly greater than the SAT-V mean of 689.93 (SD=73.14). A *t*-test indicated that this difference was significant, $t(303) = -9.341$, $p<.001$, with a moderate effect of size of .59 (Heilbronner, 2011). This supports the observation that a math tilt was present for the participants as a whole. However, the data do not indicate if a math tilt was present for each individual participant. This study suggested that the best predictors of a STEM major were academics and self-efficacy. Both variables (academics and self-efficacy) were self-reported and used a Likert-type scale as measurement (Heilbronner, 2011). Academics, in this instance, referred to how appropriate the participants thought STEM classes were; if the STEM classes were challenging, and if the STEM classes prepared them for their careers (Heilbronner, 2011). Self-efficacy was also measured by a Likert-type scale asking participants to "reflect back and rate themselves on their self-efficacy" (Heilbronner, 2011, p. 882). One of the questions posed concerning the outcome of this research (Heilbronner, 2011) was whether an individual's math ability tilt variable act as a predictor of selecting a STEM major in college? It was evident that the difference between the SAT-M and SAT-V scores was significant for the entire sample, but individual differences were not noted.

Summary

This chapter has reviewed three factors often suggested as reasons for women not entering STEM careers: self-efficacy (Betz & Fitzgerald 1987; Hackett, 1985), life-style preference (Donaldson, 1995; Eccles, 1994; Nauta et al.,1998), and math tilt (Benbow et al., 2000; Webb et al., 2002). While all three of these factors have merit in explaining the lack of women in STEM careers, self-efficacy alone does not predict educational major or career choice. While life-style preference influences females in career choice (Donaldson, 1995; Eccles, 1994; Nauta et al., 1998) it does not account for women who choose STEM careers even considering balancing work and family.

One variable contributing to females remaining in the STEM pipeline is what is referred to in the literature as a math tilt (Webb et al., 2002). This math tilt has been found in a longitudinal study, the Study of Mathematically Precocious Youth (SMPY), comprising profoundly gifted males and females being tracked over a 50-year time span (Lubinski &

Benbow, 1994). While ability level may estimate level of achievement, the longitudinal study suggested that ability pattern (e.g., intellectual tilt) predicts the nature of the achievement (Robertson et al., 2010).

To date, the math tilt has been studied in the profoundly gifted, attending the nation's top colleges and universities. It would be helpful to determine if a math tilt is present in a more typical female college population.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

Chapter three describes the research design and methods utilized in this dissertation. This chapter begins with a restatement of the purpose of the study. The chapter will also describe the participants, instrument used, research questions and hypotheses, and data analysis procedures.

Restatement of the Purpose

The purpose of this dissertation was to address the research gap regarding the impact of ability and ability tilt on choice of an academic program for women college students who have not been identified as profoundly or highly gifted.

Even though the National Employment for Women Act mandated that states develop goals for the training and placement of women in nontraditional jobs (U.S. Department of Labor, 2004), women continue not only to be under-represented in many occupations, particularly careers in science, technology, engineering and math (STEM), but they also continue to be over-represented in low pay and low status occupations (Betz & Fitzgerald, 1987; Sheye & Gilroy, 1994). Additionally, there are fewer U. S. mathematicians and engineers being developed by the American educational system (Adair, 1991) and because women continue to be under-represented in these areas, it is logical to view women as an untapped potential. It has been established that profoundly gifted females who pursued STEM studies and careers exhibited an ability tilt toward math based on SAT-M and SAT-V scores (Lubinski et al., 2006). Research has suggested that the "ability level predicts level of achievement" while "ability pattern (or tilt) has predicted nature of achievement" (Robertson et al., 2010). However, this longitudinal study was conducted on only profoundly gifted females. As a result, an important research question to consider is whether this ability tilt will be found in more typical college females at a more conventional university. If the math ability tilt is found in a more typical college female population it may enhance and inform the career counseling process to include not only interests, values, and ability, but ability tilt as well. The statistics utilized in this study included descriptive statistics, Chi Square Test for Independence, and logistic regression analysis.

This quantitative study used ACT archival data from the institutional records of a comprehensive public university in the Midwest to 1) examine the impact of an ability tilt on the choice of a college major by more typical female college students and 2) to provide information that may enhance and inform the career counseling process for women beyond interests, values, and ability; specifically, ability tilt. The ACT Mathematical subtests were utilized as independent variables to assess the impact on the dependent variable of choice of college major as measured by graduating in STEM inorganic/organic science majors.

This investigation was a secondary data analysis of existing ACT data and student graduation records. All data are the property of the institution under study and are housed on a secure server. Student IDs were given research numbers to protect the privacy of the students. ACT data and student academic data were obtained from the Office of Institutional Research. The statistics utilized in this study included descriptive statistics, Chi Square Test of Independence, and logistics regression.

Participants

Participants consisted of women students graduating during the time frame 2000 through 2013, in both nursing/allied health and inorganic sciences. Inorganic sciences consisted of: astronomy, automotive engineering technology, chemistry, civil engineering, computer engineering technology, computer engineering, computer science, construction management, electrical engineering, electrical engineering technology, integrated engineering, manufacturing engineering, software engineering, information systems, general engineering, manufacturing engineering technology, mathematics, mechanical engineering, physics, and statistics. Nursing/allied health included the following programs: dental hygiene, health sciences, biology, and nursing. All females were graduates of a midsize, Midwest state university with an enrollment of approximately 18,000 students. This university offers over 140 undergraduate programs.

Measures

In previous research an ability tilt was established by using the SAT. This ability tilt was often defined as at least one standard deviation between the math score and verbal score according to the SAT-V and SAT-M (Lubinski & Benbow, 2007; Lubinski, Webb et al., 2001). However, other researchers who used this same data set defined ability tilt differently (Achter et al., 1999; Park et al., 2007). The Achter and colleagues (1999) merely alluded to an "ability preference," never truly defining the "ability preference." Other authors (Park et al., 2007) were only minimally clearer in reporting how an ability tilt was established. Park and colleagues (2007) determined an ability tilt by subtracting the SAT-V score from the SAT-M score. If the remainder was positive, then a math tilt was established; if the remainder was negative, then a verbal tilt was established. However, this did not take into consideration the Standard Error of the Measurement.

In past research (Achter et al., 1999; Lubinski & Benbow, 2007; Lubinski, Webb et al, 2001; Park et al., 2007) a math tilt has been established using the SAT. However, to date the ACT has not been utilized to establish a math tilt. In addition, the institution under this study does not use the SAT for admission. Therefore, for the purpose of this dissertation, the ACT was used to establish if there was a math ability tilt.

The ACT is a "college readiness assessment … that assesses students' academic readiness for college" (ACT, 2007). The ACT consists of five subtests: English, Mathematics, Reading, Science, and an optional Writing Test (ACT, 2007). For the purposes of this study only two subtests were used, the English subtest and the Mathematics subtest.

The English subtest consists of 75 questions assessing punctuation, grammar, sentence structure, style, organization, and strategy. Multiple choice questions are generated from five prose passages (ACT manual, 2007). The Mathematics subtest was designed to assess mathematical skills most students have acquired by the end of eleventh grade (ACT manual, 2007). Areas covered by the ACT Mathematics subtests included pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry (Mathematics Test Description).

Reliability and Validity for the ACT

Because the ACT is an aptitude test it is based on learning that takes place in high school (Terwilliger, 1995) and is designed to assess skills students are required to have for college (Passow, 1995). The ACT results are used to determine college admission, course placement, scholarship, and career counseling (ACT, www.act.org). The ACT test manual suggests that between 30% and 55% of the variance in ACT scores is explained by a combination of high school grade point average (GPA) and course work (ACT manual, 2007). Consequently, there is a correlation between taking college-preparatory mathematics courses and higher ACT math scores (ACT manual, 2007).

The ACT is often used to determine college admission. The rationale for this use of the ACT is based on the correlation between ACT test scores and first year college grades. Results suggested moderate reliability with an *r* of .12 correlating ACT English scores and grades in English Composition; math with an *r* of .59 correlating ACT math score and grades in Honors Calculus (Terwilliger, 1995).

During two consecutive years, 1992-93 and 1993-94 the ACT assessed the validity for using the ACT test scores to predict GPAs during a student's first year of college (ACT Manual, 2007). During 1992-93 the data set was composed of 161,662 students from 334 colleges. In 1993-94 the data set was composed of 149,443 students from 261 colleges (ACT Manual, 2007). The results suggested that there was a correlation of .52 between predicted first-year college GPAs and actual GPA (ACT Manual, 2007). Thus, it can be suggested that there is a moderate relationship between the ACT scores and predicted first year college GPAs.

Research Design and Data Analysis

According to the ACT Technical Manual, the Standard Error of the Measurement for any subtest of the ACT is two points. Therefore, an individual's true score would lie on a continuum of plus or minus two points from his or her given score. In other words, if an individual received a score of 18 on the math subtest, his or her true score would fall somewhere between 16 and 20. Consequently, on any given day the individual could obtain a score between 16 and 20.

The ACT reported national averages for all subtests from 2009 through 2013 (ACT, Policy Reports, 2013). These reported national averages for Mathematics beginning with 2009 are: 2009 = 21.0, 2010 = 21.0, 2011 = 21.1, 2012 = 21.1, and 2013 = 20.9. Similarly, the national averages for English are: 2009 = 20.6, 2010 = 20.5, 2011 = 20.6, 2012 = 20.5, and 2013 = 20.2. In any of these given years, the difference in the mean for the Mathematics subtest and the English subtest is less than one point, producing a mean difference of .54.

For the purpose of this dissertation, a math tilt was established if the individual math score was +1Sd from the mean for both the inorganic majors and the organic majors.

Variables

The following independent variables were included in this study: ACT math tilt, number of completed high school math courses, and end of sophomore year GPA. The dependent variable in this study was an identified academic major choice as measured by graduation in a STEM major of organic or inorganic science. Inorganic sciences consisted of: astronomy, automotive engineering technology, chemistry, civil engineering, computer engineering technology, computer engineering, computer science, construction management, electrical engineering, electrical engineering technology, integrated engineering, manufacturing engineering, software engineering, information systems, general engineering, manufacturing engineering technology, mathematics, mechanical engineering, physics and statistics. Organic sciences consisted of: nursing, dental hygiene, health sciences, and biology.

Data Analyses

Chi Square Test of Independence and logistic regression analyses were the statistical tests used to analyze the data in this investigation. Demographic data, ACT subtest scores for English and Math, and graduation major were obtained from the Office of Admissions. The data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) version 21 (IBM Corp., 2012).

Research Question One

Research question one: Is there evidence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in inorganic sciences, math, or engineering?

H1: There is evidence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in inorganic sciences or engineering. A Chi Square Test of Independence was used to determine this.

Research Question Two

Research question two: Is there evidence of an absence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in organic science, nursing, or allied health?

H2: There is no evidence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in organic science nursing or allied health. A Chi Square Test of Independence was used to determine this.

Research Question Three

Research question three: Will math tilt, number of completed high school math courses, and end of college sophomore year GPA significantly predict a major in inorganic sciences or engineering for women graduating from a midsize, Midwest state university during 2000-2013?

H3: Using a logistic regression analysis math tilt, number of completed high school math courses, and end of college sophomore year GPA will significantly predict a major in inorganic sciences of engineering for women graduating from a midsize, Midwest state university during the time frame 2000-2013.

Summary

STEM related majors for female students is an increasingly important area of research. This study sought to understand if ACT Math tilt scores can impact the choice of a major for female students. This chapter described the research design and methodology that were undertaken in this study, including the research design, participants, instrument, variables, research questions and data analysis. Chapter 4 will present the research findings.

CHAPTER FOUR

FINDINGS

Introduction

Chapter four describes data collection and cleaning, descriptive statistics, analysis, and findings of this research project. The data were archival data, from the Office of the Registrar, of women undergraduates, graduating during the years of 2000 - 2013. The data were provided to the researcher from the Office of Graduate Studies and were converted into a database in IBM SPSS version 21 (IBM Corp., 2012). The SPSS for Intermediate Statistics (Leech, Barrett & Morgan, 2008), and How to Use SPSS (Cronk, 2012), were used in the analysis of the data.

Data Collection and Cleaning

Data were obtained on women graduating in inorganic science, math or engineering and organic science, nursing or allied health from a midsize, Midwest state university during the years of 2000 through 2013. Included in the research project were women whose ACT-math and ACT-English scores had been posted. Those without ACT scores in both math and English or posted SAT, Graduate Record Exam, Accuplacer scores, or PSAT scores were omitted. Thus, the sample consisted of 2,311 participants. Three of those participants were considered outliers and were removed from the sample; thus, leaving a *n* of 2,308 or 99.9% of the sample. The ending sample of 2,308, consisted of only women graduates who had both ACT-math and ACT-English scores posted on their record, and had graduated in the years of 2000 through 2013.

In research question three, the independent variable of number of math classes taken in high school, was unavailable from the registrar's office. Therefore, this variable was not be used in the Logistic Regression and the variable was omitted from all analyses.

Descriptive Statistics

There were 2,308, women who participated in this research project; of those 134, graduated in an inorganic science, math or engineering; 2,174, graduated in an organic science, nursing or allied health. The graduation dates for all women included the years 2000 through 2013. According to ACT.org, ACT-math and ACT-English scores range between 1, and 36 (ACT.org, 2007). In this study, the mean ACT-math score for women graduating in organic science was 21.68, with a Standard Deviation (SD) of 3.89. The mean ACT-math score for women graduating in inorganic science, math or engineering was 25.24 with a SD of 4.27. The mean for all math scores, both organic and inorganic majors, was 21.89, with a SD of 3.99. The mean for all English scores, both organic and inorganic majors, was 21.47, with a SD of 4.29. To determine a math tilt, the ACT-math mean score was rounded to 22 and the ACT-math SD was rounded to 4. Thus, for this study, any ACT-math score above 26, was considered to be a math tilt.

The racial make-up of the sample was predominantly white (95.4 percent). However, it should be noted that 604, of the 2308 participants, did not state their race. Asian students comprised 1.6 percent of the sample and black students 1.1 percent. Latina/o and American Indian or Pacific Islander comprised less than one percent of the sample.

Variables

The variables in this study included the following independent variables: ACT math tilt, number of completed high school math courses, and end of sophomore year GPA. The dependent variable in this study was an identified academic major choice as measured by graduation in a STEM major of organic or inorganic science. Inorganic sciences consisted of: astronomy, automotive engineering technology, chemistry, civil engineering, computer engineering technology, computer engineering, computer science, construction management, electrical engineering, electrical engineering technology, integrated engineering, manufacturing engineering, software engineering, information systems, general engineering, manufacturing engineering technology, mathematics, mechanical engineering, physics and statistics. Organic sciences consisted of: nursing, dental hygiene, health sciences, and biology.

Research Question One

Research question one: Is there evidence of a math ability tilt in the ACT scores of women who graduated from a midsize, Midwest state university between 2000 - 2013 with a major in inorganic sciences, math or engineering?

H1: There is evidence of a math ability tilt in the ACT scores of women who graduated from a midsize, Midwest state university between 2000-2013 with a major in inorganic sciences, math or engineering using a Chi Square Test of Independence.

IBM-SPSS version 21 (IBM Corp., 2012) was used to run a Chi Square Test of Independence to answer research question one (Cronk, 2012). That is, the expected math tilt value for inorganic majors and organic majors were compared with a 2 x 2 matrix. The expected count for women who graduated with a major in inorganic science, math or engineering who will exhibit no math tilt was 106.5, while it was expected that 27.5 would exhibit a math tilt in their ACT-math score. The actual count for women who graduated with a major in inorganic science or engineering who exhibited no math tilt in their ACT-math score was 69 while the actual count for those exhibiting a math tilt was 65.

The expected count for women who graduated with a major in organic science, nursing, or allied health who will exhibit no math tilt was 1727.5; while it was expected that 446.5 would exhibit a math tilt in their

ACT-math scores. The actual count for women who graduated with a major in organic science, nursing, or allied health who exhibited no math tilt in their ACT-math score was 1765, while the actual count of those in organic majors who exhibited a math tilt was 409.

Thus, there was a significant relationship between type of major and math tilt, $X^2(1) = 68.20$, $p<.001$. Specifically, women graduating with inorganic science majors had significantly more math tilt in their ACT-math scores than would be expected. This was significant at the .001 level of confidence.

Research question Two

Research question two: Is there evidence of a math tilt in the ACT scores of women who have graduated from a midsize, Midwest state university between 2000-2013 with a major in organic science, nursing, or allied health?

H2: There is no evidence of a math tilt in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in organic science nursing or allied health using a Chi Square analysis.

IBM-SPSS version 21 (IBM Corp., 2012) was used to run a Chi Square Test of Independence to answer research question two (Cronk, 2012). The expected count for women who graduated with a major in organic science, nursing, or allied health who will exhibit no math tilt was 1727.5;

while it was expected that 446.5 would exhibit a math tilt in their ACT-math scores. The actual count for women who graduated with a major in organic science, nursing, or allied health who exhibited no math tilt in their ACT-math score was 1765, while the actual count of those in organic majors who exhibited a math tilt was 409.

The results for the number of participants in organic science, nursing, or allied health to have a math tilt was not significant. That is, women graduating with organic sciences majors had less math tilt in their ACT-math scores than would be expected.

Research Question Three

Research question three: Will math tilt, number of completed high school math courses, and end of college sophomore year GPA significantly predict a major in inorganic sciences or engineering for women graduating from a midsize, Midwest state university 2000-2013?

H3: Using a logistic regression analysis, math tilt, number of completed high school math courses and end of college sophomore year GPA will significantly predict a major in inorganic sciences or engineering for women graduating from Minnesota State University, Mankato during the time frame 2000-2013.

Note that the independent variable, of number of math classes taken in high school, was unavailable from the registrar's office. Therefore, this variable was not used in the Logistic Regression and the variable was omitted from the analysis.

Assumptions of Logistic Regression

There are few major assumptions for logistic regression (Leech et al., 2008). For this dissertation, sample size, and multicollinearity have been the assumptions that were resolved in this dissertation.

Sample Size. The sample should be large enough for the number of predictors. For instance, small samples might result in high standard errors. It is suggested that the sample size be a minimum of "20 cases per predictor" (Leech et al., 2008, p. 114). The sample size of this analysis (n = 2,309) sufficiently satisfied this assumption. Relatedly, however, since the number of participants in the inorganic group was 135 and the number of participants in the organic group was 2,174, it was determined that the assumption that the samples of organic, nursing, or allied health science and inorganic science, math or engineering are of equal or similar size groups was not met. Therefore, a random sub-group was formed from the organic group by using IBM-SPSS. The new random sample contained a total of 269 participants, resulting in 134 in organic science, nursing, or allied health majors. There were 135 in the inorganic, math, or engineering majors.

Multicollinearity. Multicollinearity occurs when the independent variables are highly correlated (Leech et al., 2008). In this study, it was confirmed that this assumption was met.

Descriptive Statistics for the Random Sample Sub-group

The inorganic science majors had a Mean Sophomore GPA of 3.44, with a SD of .45. The ACT-math Mean was 25.24, with a SD of 4.27. The ACT-English Mean was 22.87, with a SD of 4.71. All women in the inorganic science sample were either white, Asian, or did not report their race. There were 65, women in the inorganic science sample who had a math tilt.

The organic science majors had a Mean Sophomore GPA of 3.44, with a SD of .45. The ACT-math mean was 21.40 with a SD of 4.28. The ACT-English mean was 21.22, with a SD of 4.36. All races were included in organic science major group. However, white was the predominant one with a percentage of 94. There were 26, women in the organic science majors subsample who had a math tilt.

IBM-SPSS version 21(IBM Corp., 2012) was used to run a Logistic Regression to determine if either math tilt or sophomore year GPA would significantly predict a major in inorganic sciences or engineering (Leech et al., 2008). Since the number of high school math courses was not available, that variable was not used in the equation.

The Sophomore GPA was the same for both groups, and was determined to have no effect on the choice of a major. The Nagelkerke R Square is .000 (R^2=.000). In other words, 0 percent of the variance in major choice was explained by Sophomore year GPA. Therefore, Sophomore year GPA did not help to predict a major in organic or inorganic sciences in this study. If the sophomore GPA was known, a prediction of science major would be correct 51.3 percent of the time.

The logistic regression results indicated that 13.3 percent of the variance in choice of a major was explained by the ACT-math tilt (R^2=.133, p =< .001). The logistic regression indicated that all the variables entered account for the variance. If sophomore GPA accounts for 0 percent of the variance, then math tilt was responsible for all the variance in this particular study. If it is known that the participant had a math tilt, her major could be predicted 64.7 percent of the time. Math tilt was significant in identifying a major. The value of Exp(B) was less than one (Exp(B)=.238). This demonstrated that women with a math tilt were more likely to choose an inorganic, math, or engineering major.

Summary

This chapter consisted of collection and cleaning of data, descriptive statistics, variables, and three research questions. The statistical analyses were described for each research question; Chi Square Test of Independence and Logistical Regression were the statistics used in this dissertation. It was found that more women who majored in inorganic science, math or engineering exhibited a math tilt than would be expected. Relatedly, it was found that women who possessed a math tilt were more likely to choose an inorganic science, math or engineering major. All the hypotheses were supported by the statistical results.

Chapter Five

Discussion of Findings

Introduction

This quantitative study used ACT archival data from the institutional records of a comprehensive public university in the Midwest, to 1) examine the impact of an ability tilt on the choice of a college major by a more typical female college student sample, and 2) to provide information that may enhance and inform the career counseling process for women beyond interests, values and ability, specifically ability tilt. The ACT Mathematical subtests were utilized to calculate math tilt. Math tilt was utilized as an independent variable to assess the impact on the dependent variable of choice of college major as measured by graduating in STEM inorganic/organic science majors.

Overview of the Study

The National Employment for Women Act mandated that states develop the training and placement of women in nontraditional jobs (U.S. Department of Labor, 2004). Two significant advantages of work in nontraditional jobs for women include better benefits and better pay. Data compiled in 2002 indicated that salaries for nontraditional occupations were reported to be 20% to 30% more than for traditional female jobs (AFSCME, 2008).

Women continue to not only be under represented in many occupations, particularly careers in science, technology, engineering, and math (STEM), but they also continue to be over represented in low pay and low status occupations (Betz & Fitzgerald, 1987; Scheye & Gilroy, 1994), with few opportunities for advancement (Betz & Fitzgerald, 1987); thus, demonstrating a gender gap. While the gender gap is closing in some fields such as law and biology (Lubinski, Benbow, Shea, Eftekhari-Sanjani, & Halvorson, 2001), there remains a disproportion in careers such as engineering and math.

Women who possess math and science abilities tend to pursue organic sciences, such as biology or health sciences, and humanities while men who possess math and science abilities tend to pursue engineering and physical science, such as chemistry or physics (Lubinski, Benbow et al., 2001). One variable that has been suggested for women choosing STEM careers, is what has been referred to in the literature as a math tilt (Webb et al., 2002). For instance, in one study an intellectual math tilt was found when scores on the SAT-M are at least one standard deviation above the SAT-V (Benbow et al., 2000). This math tilt has been found in a longitudinal study, the SMPY, comprising profoundly gifted males and females being tracked over a 50-year time span (Lubinski & Benbow, 1994). In another study math tilt was defined as the subtraction of the SAT-V from the SAT-M (Park et al., 2007). If the remainder was positive, it was considered a math tilt.

When comparing a math tilt of 714 first and second year graduate students (368 men and 346 women) from math and science programs of 15 top U.S. universities, no gender differences were found regarding a math tilt (Lubinski, Benbow et al., 2001); a math tilt was found for both men and women graduate students. These findings suggested that if an individual exhibited a math tilt, a STEM career in inorganic science, math or engineering was usually the outcome.

For this study, a math tilt was established when the ACT-math score was more than one SD over the math mean for the participants in this study. A Chi Square Test of Independence and logistic regression analyses were the statistical tests used to analyze the data in this study. The data were analyzed using the IBM-SPSS version 21 (2012) as well as two books on SPSS (Cronk, 2012; Leech et al., 2008).

Discussion of Results

Research Question One

Is there evidence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize, Midwest state university with a major in inorganic sciences or engineering?

A Chi Square Test for Independence was used to determine if women who majored in inorganic sciences, math, or engineering would demonstrate a math tilt. The findings suggested that women who enter the inorganic sciences, math, or engineering demonstrated a math tilt more than would be expected by chance. This is congruent with the studies of highly gifted students using the SAT to demonstrate a math tilt (Achter et al., 1999; Lubinski, Webb et al., 2001; Park et al., 2007; Wai et al., 2005; Webb et al., 2002).

Initially there were questions concerning if a math tilt would be demonstrated in the ACT. The score range on the ACT is not as great as the score range on the SAT. Additionally, the SAT and ACT are reported to assess different things. The ACT is a "college readiness assessment … that assesses students' academic readiness for college" (ACT, 2007). The SAT is considered an aptitude test, meaning it test the potential of a student (top10onlinecolleges.org/faq/what-is-the-difference-between-the-sat-and-the-act, 2014).

Because the ACT is an achievement test, it is based on learning that takes place in high school (Terwilliger, 1995) and is designed to assess skills students require for college (Passow, 1995). Thus, the ACT results are used to determine college admission, course placement, scholarship, and career counseling (ACT, www.act.org). However, this study suggested that a math tilt can be detected using the ACT-M subscale.

Research question two

Is there evidence of a math tilt in the ACT scores of women who have graduated from a midsize, Midwest state university between 2000-2013 with a major in organic science, nursing, or allied health?

Although some of the women in organic sciences, nursing, or allied health exhibited a math tilt, results were not statistically significant, thereby supporting the hypothesis that the evidence of math tilt in this group was not significant.

Research question three

Will math tilt, number of completed high school math courses, and end of college sophomore year GPA significantly predict a major in inorganic sciences or engineering for women graduating from a midsize, Midwest state university 2000-2013?

As mentioned previously, the number of completed high school math courses were not available to the researcher. Therefore, this variable was omitted from the study. The sophomore GPA was equivalent for both groups, and was determined to have no effect on the choice of a major. The Nagelkerke R Square is .000 (R^2=.000). In other words, 0 percent of the variance in major choice was explained by sophomore year GPA.

As expected, however, math tilt was the variable that significantly predicted choice of a major. That is, women who exhibited a math tilt tended to choose inorganic sciences, engineering, or math. This was consistent with the studies conducted with profoundly gifted undergraduate students and graduate students, that found that those who had a math tilt tended to choose inorganic sciences, engineering or math (Lubinski, Benbow et al., 2001; Lubinski & Benbow,1994). Results of the investigation suggested that math tilt likely operates in a consistent manner for a more general undergraduate population as it does for the profoundly gifted.

Limitations of Study

There are several limitations that need to be highlighted when considering the results of this study. The first is that the study was conducted at only one institution. The 50-year longitudinal SMPY study focused on a specific group of students who attended various universities, rather than students who attended a specific college or university (Lubinski, Benbow, et al., 2000).

Another limitation is the number of participants in the sample. The number of women in organic science was sufficient (2174), but the number in the inorganic science was much less (135). This sample was not balanced. This imbalance in the number of participants between organic science and inorganic had to be rectified to meet an assumption of logistic regression. A subsample was obtained to make the samples similar in number. Perhaps a more balanced sample could be obtained by widening the pool of women in inorganic sciences; consequently, using data from other colleges and universities rather than using data from only one institution.

An additional limitation of the study was that the racial make-up for this study was predominately white (95.4 percent). Therefore, the results of this study has limited generalizability to other populations.

Recommendations for Further Research

The SMPY study focused on profoundly gifted males and females over a 50-year period (Lubinski & Benbow, 1994). During the SAT assessments, a math tilt was discovered in this population and was part of the tracking for career preference (Achter et al., 1999; Lubinski, Webb et al., 2001; Park et al., 2007; Wai et al., 2005; Webb et al., 2002). This study focused on a more typical college population and used the ACT as the assessment tool. The math tilt was found in both the profoundly gifted and a typical college population. In addition, it was found using the both the SAT and the ACT.

It is recommended that future research involve multiple institutions as well as further investigations that use the ACT. Additional studies utilizing the ACT will help support the findings of this study. Furthermore, studies using a more typical population of women is also recommended.

While this dissertation focused on the variables impacting college women's choice of a major, additional studies are needed to track women after college graduation. Tracking math gifted females from high school through college and into careers will help determine variables that empower women to stay in the STEM pipeline.

Knowing if a female student has a math tilt could ultimately help track women who are intellectually suited to inorganic sciences. Other tests should be studied to determine if a math tilt exists with other assessments. Tests such as the IOWA, CogAT (Cognitive Abilities Test), and CAT (California Achievement Test) also have language and math components (Seton Testing Services). Many of these tests have assessments beginning in kindergarten through 12th grade (Seton Testing Services). If a math ability tilt can be ascertained at a much younger age, then females could be encouraged to take math courses and participate in extracurricular math experiences to empower them to enter the STEM pipeline at a much earlier age. By finding females with a math tilt at a much earlier age, they can be tracked and additional information gathered to help determine what might assist females in selecting inorganic sciences beyond a math tilt.

Recommendations for Further Practice

Studies of math tilt in females have enormous implications for the areas of education, school counseling, career counseling, and science. Knowing if a female has a math tilt before high school, she can be encouraged and directed toward inorganic science and math. Math is a discipline that builds on itself. For instance, a student can take a history course without any previous history courses. However, a study such as calculus is dependent upon previous math courses. Therefore, early identification of female students with a math tilt may help to encourage and empower women to see inorganic science, math, and engineering as possible careers.

It has been noted previously that research findings indicate that there are fewer U. S. mathematicians and engineers being developed by the American educational system (Adair, 1991). Also, it has been noted that students in other countries exhibit greater science achievement than students in the United States (Stake & Nickens, 2005). In the United States, six percent of bachelor's degrees conferred in engineering are to "nonresident aliens" (Digest of Education Statistics, 2010). That percentage rises exponentially with masters and doctoral degrees in engineering. Nonresident aliens comprised 43% of the master's degrees conferred and 58% of doctoral degrees conferred in U. S. higher education institutions (Digest of Education Statistics, 2010). Perhaps if a math tilt in student assessment, particularly female, can be identified earlier, this may aid in increasing the number of engineers and mathematicians produced in this country.

Conclusion

The purpose of this study was to explore the impact of ability and ability tilt on the choice of an academic program for female college students who have not been identified as profoundly or highly gifted. Women tend to choose careers in the helping sciences like nursing and health technicians (Farmer, 1997). In contrast, men choose science careers in engineering or "at the physician level within the health fields…" (Farmer, 1997, p. 386). Women who possess math and science abilities tend to pursue organic sciences, such as biology or health sciences, and humanities while men who possess math and science abilities tend to pursue engineering and inorganic science, such as chemistry or physics (Lubinski, Benbow et al., 2001).

A 50-year longitudinal study of the profoundly mathematically gifted students (Lubinski, Webb et al., 2001), suggested that women who entered physical science, math, or engineering exhibited an ability tilt toward math (Lubinski & Benbow, 2007; Lubinski. Benbow et al., 2001; Lubinski, Webb et al., 2001; Park, Lubinski, & Benbow, 2007; Webb, et al., 2002). This tilt pattern was apparent at 13 years of age and influenced the education and career trajectories for these cohort participants (Lubinski & Benbow, 2007).

This dissertation posed three research questions: (a) Is there evidence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize Midwest state university with a major in inorganic sciences or engineering? (b) Is there evidence of an absence of an ability tilt toward math in the ACT scores of women who have graduated during the time frame 2000-2013 from a midsize Midwest state university with a major in organic science, nursing, or allied health? (c) Will math tilt and end of college sophomore year GPA significantly predict a major in inorganic sciences or engineering for women graduating from a midsize Midwest state university during 2000-2013?

Chi Square Test of Independence and Logistical Regression were the statics used in this dissertation. It was found that more women who majored in inorganic sciences, math, or engineering exhibited a math tilt than would be expected. Relatedly, it was found that women who possessed a math tilt were more likely to choose inorganic sciences, math, or engineering major.

Several theories were considered as a lens for this study. Gottfredson's (1981) Circumscription and Compromise theory of career development was considered but rejected. Gottfredon's theory contributes to the literature in how careers are perceived to be gender appropriate. However, Gottffredson's theory does not emphasize ability

(Patton & McMahon, 2014). As a matter of fact, many theories do not acknowledge ability at all. Some of these theories include, but are not limited to, Five Factor Model, Holland, Tiedeman, and Roe (Patton & McMahon, 2014).

The Social Cognitive Career Theory (SCCT) has been suggested to have validity as an explanation of career development and is supported by the research (Hackett, Betz, Cacus, Rocha-Sing 1992). SCCT focuses on self-efficacy, expected outcomes, and goal mechanisms (Lent, Hackett, & Brown, 2008; Patton & McMahon, 2014) that interact on a continuing basis with individual factors, such as cognition and with environmental factors, such as support and barriers to career choice (Patton, & McMahon, 2014). In addition, there are specific studies that support the use of SCCT for engineering students (Inda, Rodriguez, & Pena, 2013; Hackett, et al., 1992;). However, SCCT does not explain how career choice can be ability driven.

The TWA theory was used as a lens for this study. The TWA is concerned with the fit between the individual and the work place (Dawis, 2005). The TWA proposes that individuals' abilities that meet the ability requirements of an educational or career path represent "satisfactoriness or can do," but when the individuals' interests, values, and needs are met by the career or educational path then, "satisfaction or will do" becomes the optimal situation (Robertson et al., 2010). As a result, women who have math ability but do not have a math tilt may choose a career not in the STEM pipeline opting for "can do" rather than "will do." In other words, these women who possess ability and achievement in math may meet the requirements of an educational path in inorganic science, math or engineering path (can do/satisfactoriness), but the educational path does not meet the needs of certain women (satisfaction) and they opt out of the inorganic, math, engineering pipeline and choose other career paths.

Chi Square Test of Independence and Logistical Regression were the statics used in this dissertation. It was found that more women who majored in inorganic science, math or engineering exhibited a math tilt than would be expected. Relatedly, it was found that women who possessed a math tilt were more likely to choose an inorganic, math or engineering major. All the hypotheses were supported by the statistical results.

In summary, the results of this study clearly point to the importance and need for continued investigation into a math tilt at a much younger age for not only the profoundly gifted but for all female students. Given, the limited number of females currently in the STEM pipeline it would be prudent for researchers to focus on early identification of math tilt and the variables that might support a female's continued trajectory into inorganic math or engineering careers.

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