Women in STEM: Examining the Perennial Gender Gap

BY

GENA KHODOS
B.A., University of Iowa, 2003
M.A.T., National Louis University, 2004

THESIS

Submitted as partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Educational Psychology
in the Graduate College of the
University of Illinois at Chicago, 2019

Chicago, Illinois

Defense Committee:

Kimberly Lawless, Chair and Advisor
Yue Yin
Michael Manderino, Northern Illinois University
James Gavelek
Scott Brown, University of Connecticut

To the boy, who gave me courage. To the girl, who brought me peace.

ACKNOWLEDGMENTS

My deepest appreciation to my committee members: Yue Yin, Michael Manderino, James Gavelek, and Scott Brown for their guidance and support. It has been a privilege to be your student. Thank you.

A special note of acknowledgment to my chair, Kimberly Lawless, whose patience with me borders on heroism. She has been a teacher, a mentor, a therapist, but most importantly, a friend. Her work is unparalleled and forever stands as an example of excellence. She is the consummate role model.

A nod to my longtime comrade Kathleen Paciga. Over the years she has read many drafts of drivel but sent only words of encouragement in return. She has always led by example, and I have tried to faithfully follow.

An enormous thank you to Judith Bramble, a woman in STEM I wish I had met earlier in life, but am ever so grateful to know now. Her firm hand led me through the fog on more occasions than can be counted. She is the reason this project is finished. I am forever in her debt.

Anything I have ever accomplished, be it big or small, is credited to my Mama and Papa, who, in the face of unfavorable winds, took the leap into the great unknown.

Lastly, my husband. Wings.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FIGURE PAGE

LIST OF ABBREVIATIONS

AAUW	American Association of University Women
ANOVA	Analysis of Variance
CAWMSET	Commission on the Advancement for Women and Minorities in Science, Engineering, and Technology
COE	Council for Opportunity in Education
DAST	*Draw a Scientist*
NAEP	National Assessment Education Progress
NCES	National Center for Education Statistics
PAtt	Profile attractiveness
PHum	Profile inclusion/exclusion of human element
PLang	Profile language
PSex	Profile sex
SCCT	Social cognitive career theory
SCIT	STEM Career Interest Test
SCS-ET	STEM Career Self-Efficacy Test
STEM	Science, Technology, Engineering, Mathematics
UNESCO	United Nations Educational, Scientific and Cultural Organization

SUMMARY

The underrepresentation of women in science, technology, engineering, and math (STEM) careers constitutes a major issue in both post-secondary and professional domains. The underrepresentation of women in those fields limits the talent reservoir as well as prevents women from accessing lucrative professional positions and securing their financial stability. Although past explanations of the phenomena attributed this to a gap in mathematical and scientific abilities, current research trends illustrate that women outperform men in standardized testing in STEM, and yet they remain underrepresented in STEM careers and in the achievement of STEM degrees.

One way to remediate this deficiency is to attempt to bolster female efficacy and interest in the field. As the presence of social models has been shown to influence efficacy, this study examines to what degree manipulations of social models enhances or diminishes student self-efficacy and interest.

In an experimental intervention, over 500 high school students studied the profiles of fictional scientists, all of which varied in gender, level of attractiveness, utilization of gendered language, and inclusion of a human element. The results illustrated that the type of model and the type of message matter, with the use of female language and average looking models yielding the highest results.

The results of the study suggest that students' STEM efficacy and interest respond to model manipulations.

1. INTRODUCTION TO THE STUDY

1.1 Background

In 2005, at the behest of Congress, the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine joined efforts to examine the United States' degree of scholastic rigor, professional preparedness, and position in the global economy. The compilation of these efforts, entitled *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, stressed the immediate need for advancing the fields of science and technology, suggesting that if America wishes to maintain her role as a player in the international market, she must increase her talent pool in the fields of science, technology, engineering, and mathematics (STEM).

The committee reconvened 5 years later to examine the progress made on the recommendations set forth in the 2005 report. The conclusion of the 2010 assessment, *Rising Above the Storm Revisited: Rapidly Approaching Category 5*, was that very little improvement had occurred in the fields of math and science (National Center for Education Statistics [NCES], 2017).

In an effort to ameliorate the seemingly floundering fields, the issue of gender participation was examined. From an educational perspective, it was reassuring to find that a number of technological and scientific disciplines have seen an equal distribution of the number of male and female graduates, and yet some disciplines graduate disproportionately fewer numbers of women than men (National Science Foundation [NSF], 2011). The acute absenteeism of women in those fields results in untapped intellectual capital as well as stagnation of scientific and technological development.

1.2 Significance of the Problem

The exploration of the disparity between men and women pursuing degrees and subsequent careers in natural sciences, mathematics, and engineering is hardly novel. Explanations for the gap go back as early as the 1970s, seemingly reaching an apex in 2010 with a Congressional investigation (Hill, Corbett, & St. Rose, 2010). At the core of all this activity is a relatively simple question: Why are there so few girls participating in the math and science fields? To put it more expansively, what accounts for the gender disparity as it pertains to the study and professional pursuit of math and science?

While it is well established that the gender gap exists, why this gap matters is worthy of discussion. The zealous pursuit to close the chasm, a zeitgeist evidenced by the fervor and money it has attracted, is neither trendy nor is it in vain. The exclusion of women from the fields of math and science, be it intentional or self-inflicted, has two significant consequences: (a) it narrows the intellectual potential of the math and science fields, and (b) it hinders women from reaching their full earning potential.

Let us first consider the implications of excluding women from the STEM field as a whole. Limiting the population of mathematicians and scientists prevents access to the full breadth of intellectual capital, thus making the pool of ideas and perspectives all the more shallow. A robust body of researchers provides the opportunity for different perspectives and may yield different questions. One needs only to consider the classic use of exclusively male subjects in medical research. When research is spearheaded by males, the opportunity for excluding any kind of female perspective seems almost inevitable. It was, in fact, not until 1994 that the U.S. National Institutes of Health (NIH) issued guidelines for studying and evaluating gender differences in clinical trials so as to certify that the safety of drugs would be thoroughly investigated in patients of both sexes (NIH Guidelines on the inclusion of women and minorities as subjects in clinical research, 1994; 59 Fed. Reg. 14508-14513). Prior to the implementation of this policy, women had not been included in pharmaceutical studies. This exclusion meant information on the effects of those drugs on women was scant. If women had a side effect profile different from that of men, it would be utterly missed (Light, Lovell, Butt, Fauvel, & Holdcroft, 2006), not only to the detriment of the women themselves but also to the pharmaceutical companies. A 2005 study reported that eight out of ten prescription drugs were withdrawn from the U.S. market because of women's health issues (Simon, 2005). This represents an enormous waste of research money as a consequence of neglecting gender research and a dearth of female researchers.

From an earning potential, the underrepresentation of women in STEM is an economic catastrophe. Regardless of gender, STEM professionals earn an average of 33% more than their non-STEM counterparts (U.S. Department of Commerce, 2011). As a result of this discrepancy, women who are participating in this field debilitate their own economic advancement. Reports on whether the earnings of women in STEM share parity with those of men are inconclusive. While Dey and Hill (2007) found that women in math and science can earn as much as 95% of their male counterparts' salaries, an article from *The New Scientist* argues that women working in science and engineering make one fifth less than their male colleagues (Fleming, 2018). Regardless of which is more accurate, numerous findings suggest that a significant gender-based disparity remains.

It is also reasonable to consider the long term consequences of the female earning lag. Given that women will, over time, earn less than men, they will also have saved far less for retirement and will have a lesser social security contribution. Because women live longer and spend more on healthcare (Alemayehu & Warner, 2004), they will require more, not less, savings to support them. In order to ensure that women have a reasonable and equitable standard of living, it is imperative to grant women access to the higher paying and faster growing STEM fields.

1.3 Distribution of the Problem

The loss of women from the STEM pipeline is reflected in trends observed in higher education. The U.S. Department of Education reported that in 2016, women accounted for over 57% of all bachelor's degrees earned. However, fewer than half of the degrees earned in engineering, physical sciences, mathematics, and computer sciences were by women (Digest of Education Statistics, 2016). The gender distributions for bachelor's, master's, and doctoral degrees in science and engineering (National Center Clearinghouse, 2018) are illustrated in Figures 1 through 3.

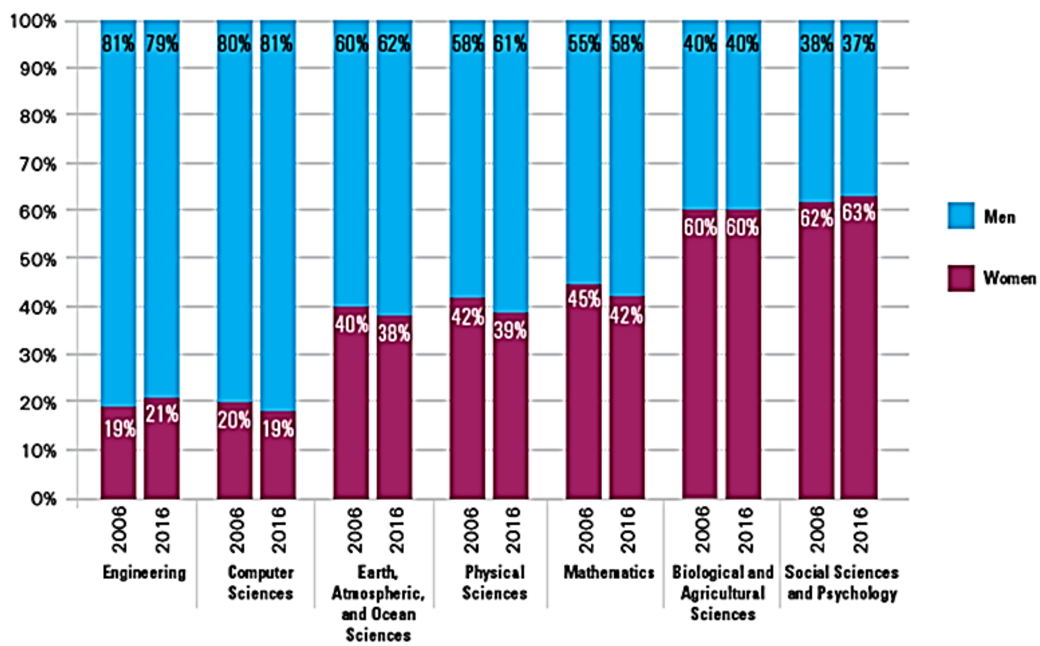

Figure 1. Gender distribution of bachelor's degrees in science and engineering disciplines (2006, 2016). Adapted from "Science & Engineering Degree Attainment – 2017," by National Student Clearinghouse Research Center, 2017, *National Student Clearinghouse Online*. Retrieved from https://nscresearchcenter.org/snapshotreport-science-and-

engineering-degree-completion-by-gender/. Copyright 2017 by National Student Clearinghouse.

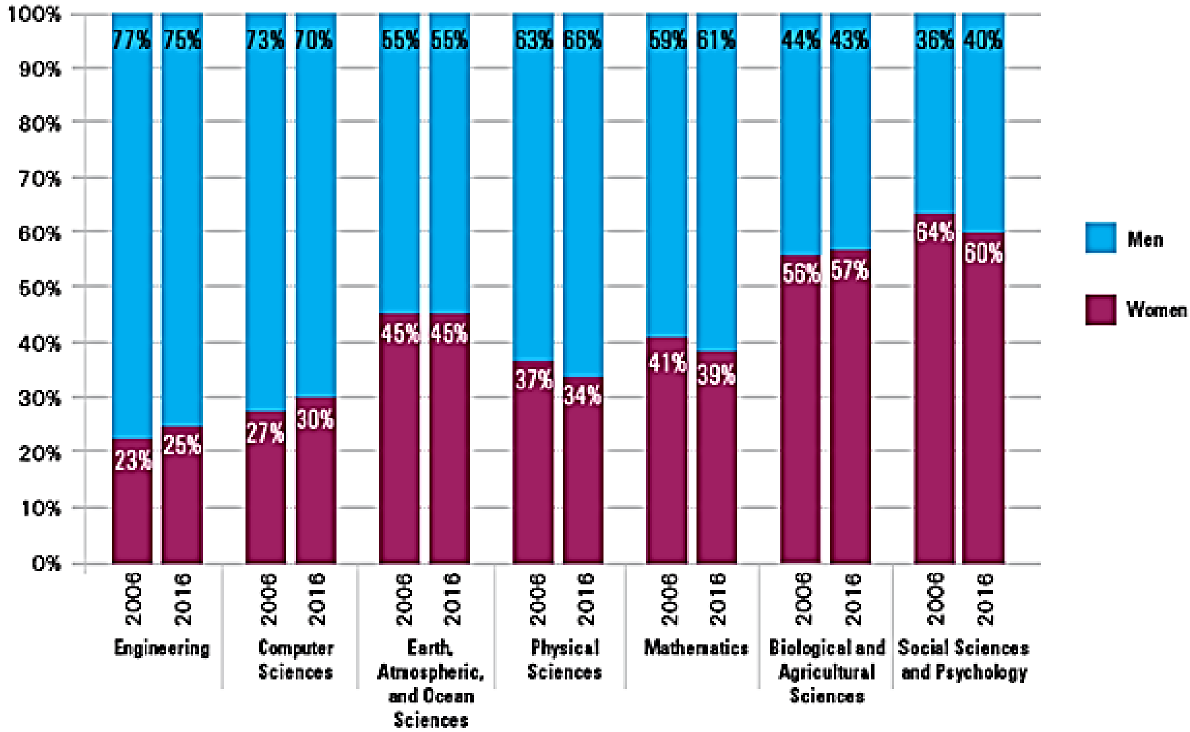

Figure 2. Gender distribution of master's degrees in science and engineering disciplines (2006, 2016). Adapted from "Science & Engineering Degree Attainment – 2017," by National Student Clearinghouse Research Center, 2017, National Student Clearinghouse Online. Retrieved from https://nscresearchcenter.org/snapshotreport-science-and-engineering-degree-completion-by-gender/. Copyright 2017 by National Student Clearinghouse.

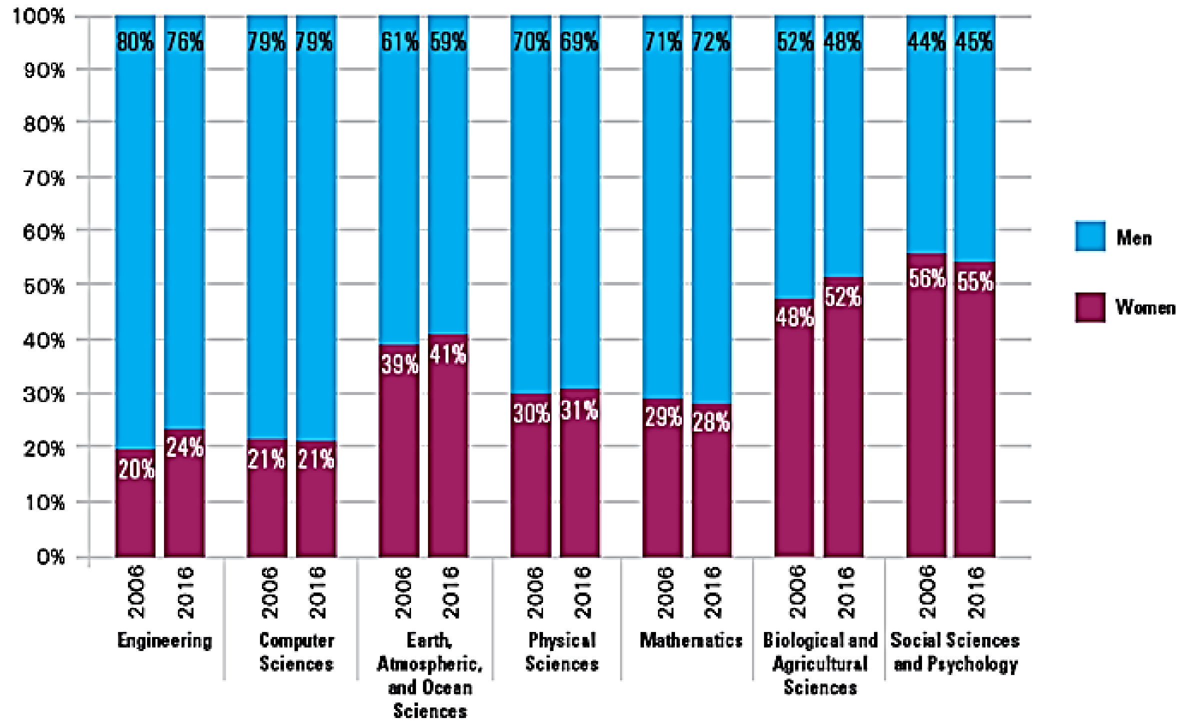

Figure 3. Gender distribution of doctoral degrees in science and engineering disciplines (2006, 2016). Adapted from "Science & Engineering Degree Attainment – 2017," by National Student Clearinghouse Research Center, 2017, National Student Clearinghouse Online. Retrieved from https://nscresearchcenter.org/snapshotreport-science-and-engineering-degree-completion-by-gender/. Copyright 2017 by National Student Clearinghouse.

In 2016, women earned roughly 49% of all science and engineering bachelor's degrees, 42% of the master's degrees, and 39% of doctorates. However, an examination of the chart illustrates that there is considerable variation among the disciplines. While the social sciences, psychology, and biological and agricultural sciences see little disparity between the genders, and in some instances favor the female students, the other four categories highlight a much deeper chasm. This, in turn, manifests itself in the workforce, whereas in 2015 women accounted for slightly more than half of the college educated workforce, they accounted for only 25% of college educated STEM jobs. Although the 25% may seem dismal at first glance, it is all the bleaker when one considers the degree to which is it inflated by the health and social sciences. It is worth noting that although there is no gender disparity in the health sciences, the most important medical research is still being done by men. Women may have a solid 51% foothold in the biological and medical careers, suggesting an absence of disparity, yet they are still excluded from high powered positions, such as professorships and department leadership. (National Research Council, 2010). A report published as recently as May of 2018 highlights that female authorship is underrepresented in prestigious publications, defined as highly competitive articles attracting the highest citation rates published in highest-impact journals. The study goes on to say that multi-author articles with male key authors are more frequently cited than articles with female key authors (Bendels et al., 2018).

1.4 **Pertinent Research**

While the studies relating to the participation of women in STEM are comprehensive in scope, they are not without error. Frequently, these studies (Chen, 2013; Hill et al., 2010; Ong, 2010) refer to the wide array of math and science disciplines ubiquitously as STEM. Therefore, STEM becomes a bit of a misnomer, as the varying disciplines are vastly different from each other, requiring different foci of study and skill. Comparing the academic and professional requirements of, say, a phlebotomist with an astrophysicist, both STEM professions, is neither useful nor particularly informative when looking at gender career choices and disparities in the fields.

With the gender disparity well reported and at the forefront of national consciousness, the federal response to the issue was quick and enthusiastic. In 2000, the Commission on the Advancement for Women and Minorities in Science, Engineering, and Technology (CAWMSET) published its findings on the science, engineering, and technology labor force. Recognizing the stark omissions of minority groups in the field, the committee called for drastic changes to allow for greater inclusion of underrepresented populations in science, engineering, and technology. The Obama administration thrust the gap further into public awareness when, in conjunction with the *Race to the Top* (2009) initiative, the White House Council on Women and Girls (2012) highlighted President Obama's challenge to "emphasiz[e] teaching girls math and science" (p. 20). This was followed with a 2012 creation of a STEM Master Teacher Corp, aiming to improve STEM education. Another glance at the Figures 1, 2, and 3, though, suggest that despite these national calls to action, the disparity between male and female pursuits of math and science is still ever-present.

Were we to explore this quandary in the early 20th century, we might profess that it was a lack of cognitive prowess or a diminished genetic composition that renders females so powerless in such a rigorous field (Benbow & Stanley, 1980; Cole, 1979; Graybill, 1975). This sweeping underestimation of female ability would be supported by test scores, which did indeed show that males outperformed females. In recent decades, however, the tide has turned, and female students have closed the achievement gap (AAUW, 2008, 2010; COE, 2009; NCES, 2007). With female cognitive abilities no longer a plausible explanation for an absence of women in the math and sciences, research had turned to social issues.

Recent explanations of the gender disparity in STEM suggest that, among other concerns, female students are marginalized during instruction, lack support from home, and are devoid of role models. Additionally, girls are bombarded with social stereotypes and cultural norms that support male ability and diminish female competence (AAUW, 2010; Andre, Whigham, Henderson, Wingfield, & Chambers, 1999; Herbert & Stipek, 2005; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Simpkins & Daivd-Kean, 2005). Research also suggests that girls are not inherently disinterested in STEM, but instead grow disinclined to participate as they advance through the educational process. Furthermore, although girls show interest in science in elementary school, by middle school both interest and confidence have waned (AAUW, 1999; Burke & Mattis, 2007; Fennema & Sherman, 1978; James & Smith, 1985; White, 1992). As such studies become more ubiquitous, the focus has continued to be on identifying other, possibly less conspicuous, variables that may serve as hurdles to female participation.

1.5 Theoretical Framework

Albert Bandura's (1997, 1999) social cognitive theory is a method for explaining human choices and personal development. The theory argues that people are self-organized, proactive, self-regulating, and capable of agency. Bandura (1977) goes on to suggest that among the processes of human agency, none are more salient than self-efficacy: an individual's belief that her desired outcomes are contingent on her actions. In other words, it is personal self-confidence in the ability to achieve a desired outcome. Although many forces work as factors of influence on human behavior, all are "rooted in the core belief that one has the power to produce effects by one's actions" (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001, p. 20). And so, if one were to explore female education and subsequent career choices, self-efficacy is a natural starting point.

Incorporating self-efficacy with career choice became Lent, Brown, and Hackett's (1994) social cognitive career theory and strove to create an elaborate framework for addressing the development of career interest and subsequent pursuit by linking self-efficacy with professional trajectories. The theory sought to examine how (a) people made academic and career choices, (b) applied those choices, and (c) achieved personal career goals (Lent et al., 1994).

What is particularly interesting about the construct of self-efficacy, and the subsequent evolution of the social cognitive career theory, is that self-efficacy is pliable, meaning that it can change and adjust according to circumstance. As self-efficacy is essentially an assessment of one's own confidence, a change in the environment can enhance or diminish that confidence. As such, self-efficacy can be regulated internally, but it can also be manipulated externally (Barak, Shilo, & Hausner, 1992; Betz & Borgen, 2000; Betz & Schifano, 2000; Natua, Kahn, Angell, & Cantarelli, 2002). It then makes sense that purposeful manipulation of self-efficacy, as it pertains to career choice, is plausible. To put it more colloquially, manipulating a person's career self-efficacy may impact the career path they pursue.

How would this be done? Self-efficacy is the basis of human agency (Bandura, 1989). It is the assertion that one is in possession of the skill set to perform a task or behavior successfully. This personal perception of ability, or confidence, is contingent on four factors: (a) past experience, (b) vicarious experience gained from observing others, (c) social encouragement, and (d) personal state of affect. Any one of these factors can influence efficacy. And although personal experience exerts the most influence in either enhancing or diminishing confidence, models also serve as a strong influence.

The value of models is that they provide an opportunity to vicariously learn skills, beliefs, or behaviors while simultaneously providing information about personal self-efficacy (Bandura, 1986). More simply put, models serve as a means of personal comparison. If one observes a model fail at a seemingly uncomplicated task, one's efficacy to perform that task successfully is undermined (Eccles, Midgley, & Adler, 1984). If, in turn, one sees a model succeed, especially if that model is deemed as having similar attributes to the observer, then the self-efficacy to succeed at a similar task is enhanced (Schunk, 1987).

This is a critical point because individuals actively seek out models who can demonstrate mastery of a trait we wish to possess. When a model embodies our aspirations, we can rely on their skill and strategies as worthy of emulation. As such, it is both plausible and thoroughly cited throughout this paper that the right kind of model may exert influence over a girl's math and science self-efficacy and possibly subsequent education and career choices.

While there already exists a robust body of research on the varying personal attributes of models, such as gender, age, and race (Hendy & Raudenbush, 2000; Kim & Baylor, 2006; Schunk, 1987; Schunk & Zimmerman, 2007), as well as the degree of influence of these attributes on self-efficacy, what is absent from this discussion are the physical attributes of the model, most specifically, the model's level of physical attractiveness. Past research on model attractiveness (Baron, 1970) was concerned with the degree of attitude similarity between the subject and the model, but the element of pulchritude appears to be untapped.

While the discussion of physical beauty may seem superficial, there is an entire body of research built on studying the social advantages bestowed upon attractive people (Dion, Berschield, & Walster, 1972). The "what is beautiful is good" construct argues that attractive people are perceived as having a more appealing personality and a more successful life than people not generally found attractive. Bargh and Chartrand (1992) suggest that we implicitly classify positive things together in our subconscious. As such, we can assume that our mind couples attractive with good and average-looking with bad.

How does this pertain to the discussion at hand? If we take a step back and consider the argument that self-efficacy governs our actions, and that self-efficacy can be manipulated by models, while at the same time keeping in mind that attractiveness matters, it could make sense that the physical attributes of the model may influence the degree to which the model is effective in manipulating efficacy. In the context of women in STEM, it plays out in the following matter: self-efficacy guides the decisions girls make about future education and subsequent careers. Girls' self-efficacy in their ability to be successful in a STEM field can be moderated by a model. If a STEM model presented is desirable for the purposes of emulation, then girls' STEM efficacy can be enhanced and thus yield an increased participation in STEM. The length of the lever arm, then, is the degree of attractiveness.

It is then worth pausing to examine the types of STEM-related models currently available to girls. Social models are no longer limited to the girls' immediate community, as technological advances have made model exposure borderless and without cultural boundaries. The media and its opulence of models exert a great deal of influence over adolescent girls, who have a heightened sensitivity to the types of models to which they are exposed (Steinke, 2005). Being cognizant of the types of STEM models girls encounter, be it in the media or not, is an important step in understanding the role these models may play in shaping the female adolescent perspective of women in STEM as well as the consequent academic and career choices girls may make.

1.6 Problem Statement

This study seeks to explore whether the physical attractiveness of a STEM model impacts the STEM self-efficacy of female high school students. While research has that models are a strong force in either the enhancement or abatement of self-efficacy, little is known about the impact of physical attractiveness on the influencing power of the model. The shortage of women in STEM majors and STEM professions is well documented. It is then the objective of the study to see if efficacy can be manipulated by controlling the types of models seen by students. By exploring somewhat unconventional ways of enhancing efficacy, we make strides toward understanding how to bolster female involvement in STEM.

1.7 Research Statement and Hypothesis

The primary purpose of this study is to explore the relationship between STEM self-efficacy and STEM career interest with five independent variables: gender of the student (male or female), gender of the model (male or female), attractiveness of the model (attractive or average looking), use of gendered language in the discussion of STEM (male or female), and incorporation of a human interest in discussion of STEM (human interest component included or human interest component excluded). This study will seek to explore whether a STEM model biography with variations of gender, attractiveness, language used, and the inclusion of a human component varies in degrees of influence on male and female student STEM-related self-efficacy and interest. The key finding of this study will be to determine the degree to which interest and self-efficacy can be maneuvered by controlling the type of STEM model seen by students.

The inclusion of all the variables yields a total of 49 research questions and hypotheses. For the purposes of brevity, I will identify those of central interest, although one-way, two-way, and three-way effects will all be explored.

1.7.1 Outcome Variable 1: Science, Technology, Engineering, and Mathematics Self-Efficacy

RQ1: Is there a significant difference in STEM task self-efficacy following exposure to an attractive or average looking model?

H01: There is no significant difference in STEM self-efficacy following exposure to an attractive or average looking model.

HA1: There is a significant difference in STEM self-efficacy following exposure to an attractive or average looking model.

RQ2: Is there a significant difference in STEM self-efficacy following exposure to a model with or without a human interest context?

H02: There is no significant difference in STEM self-efficacy following exposure to a model with or without a human interest context.

HA2: There is a significant difference in STEM self-efficacy following exposure to a model with or without a human interest context.

RQ3: Is there a significant difference between STEM self-efficacy following exposure to a model biography with male gendered language or with female gendered language?

H03: There is no significant difference between STEM self-efficacy following exposure to a model biography with male gendered language or with female gendered language.

HA3: There is a significant difference between STEM self-efficacy following exposure to a model biography with male gendered language or with female gendered language.

1.7.2 Outcome Variable 2: Science, Technology, Engineering, and Mathematics Career Interest

RQ4: Is there a significant difference in STEM career interest following exposure to an attractive or average looking model?

H04: There is no significant difference in STEM career interest following exposure to an attractive or average looking model.

HA4: There is a significant difference in STEM career interest following exposure to an attractive or average looking model.

RQ5: Is there a significant difference in STEM career interest following exposure to a model with or without a human interest context?

H05: There is no significant difference in STEM career interest following exposure to a model with or without a human interest context.

HA5: There is a significant difference in STEM career interest following exposure to a model with or without a human interest context.

RQ6: Is there a significant difference between STEM career interest following exposure to a model biography with male gendered language or with female gendered language?

H06: There is no significant difference between STEM career interest following exposure to a model biography with male gendered language or with female gendered language.

HA6: There is a significant difference between STEM career interest following exposure to a model biography with male gendered language or with female gendered language.

This study will use a 2x2x2x2 full factorial design to explore the effects of student gender, model attractiveness, model gender, gendered language and human interest context on STEM task self-efficacy as measured using an author developed survey tool. Research questions will be answered using a four-way ANOVA exploring all interactions up to three-way interactions.

2. A Historical Perspective on the Gender Disparity in Science

2.1 Introduction

The growing demand for women in science, technology, engineering, and mathematics is met with a significant shortage of individuals to fill those positions. Female presence in STEM is integral as the fields facilitate processes for finding solutions to threats posed by global challenges, such as climate change, global health epidemics, and increased income inequality. Women are ubiquitously underrepresented in their fields, and this dearth can be traced back to their early educational experiences, where innumerable factors of influence are in play. The U.S. Department of Commerce puts it succinctly:

Our science, technology, engineering and math (STEM) workforce is crucial to America's innovative capacity and global competitiveness. Yet, women are vastly underrepresented in STEM jobs and among STEM degree holders despite making up nearly half of the U.S. workforce and half of the college-educated workforce. Although women fill close to half of all jobs in the U.S. economy, they hold less than 25% of STEM jobs. This has been the case throughout the past decade, even as college educated women have increased their share of the overall workforce. Women hold a disproportionately low share of STEM undergraduate degrees, particularly in engineering (Beede et al., 2011, p. 1).

A 2015 survey by Manpower Group found that there is a global talent shortage of 38% and that the top ten hardest jobs to fill are within STEM. That same year, the United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute for Statistics (2015) estimated that just 28% of scientific researchers worldwide are women.

The low participation of women in STEM is evident at all levels of education, with a trending decrease in female presence as the level of education rises (Chavatzia, 2017). The trend is reflected in the labor market where there is further loss (Glass, Sassler, Levitte, & Michelmore, 2013). The disparity in female participation in STEM is not uniform. As illustrated in the Applicant and Matriculant Data Tables (2017), fields like medicine do not indicate a shortage of women. This may be because girls tend to do relatively better in science as opposed to mathematics, which may explain why they tend to choose science-related fields of study in higher education, such as biology, chemistry, and medicine, as opposed to more mathematics-oriented fields of study, such as physics and engineering—a tendency which continues in the labor market.

These gender difference do not start at the highest levels of professional achievement, they start as early as middle school, with girls expressing dislike for STEM-related disciplines (Brotman & Moore, 2008; Tan, Calabrese Barton, Kang, & O'Niell, 2013; Weinburgh, 1995). The reasons for these disparities are seemingly innumerable, including sociocultural preconceptions among young people, especially as it pertains to which professions are acceptable for men and which are acceptable for women (Archer et al., 2010; Baker, 2016). Education plays a significant role, especially in terms of gender-sensitive policies, teacher training, and inclusion of learning materials that are free from stereotypes. Additionally, there is the crucial absence of female STEM social models who can serve as examples for girls interested in a possible pursuit of the field (Carrignton, Tymms, & Merrell, 2008; Milgram, 2011). All of these factors combine to influence student confidence toward STEM-related subjects, which can in turn affect achievement as well as future education and career trajectories.

As a psychological variable, confidence is a salient one. Shown to influence task selection, task engagement, and persistence, student confidence—later discussed and referred to as *self-efficacy*—is essential when considering why some students choose to pursue STEM whereas others avoid it (Bandura et al., 2001; Rittmayer & Beier, 2008). What makes self-efficacy such an interesting consideration is that rather than being static it is malleable, susceptible to environmental forces, and can be manipulated (Bandura, 1977). One of these forces is the presence of models. Models have been shown to be important sources of information as it pertains to the development or abatement of self-efficacy: A strong, relatable STEM female model can enhance female self-efficacy and possibly influence her to pursue the field.

With this in mind, the purpose of the study is to explore the manner in which manipulating the type of model to which students are exposed impacts their STEM interest and self-efficacy. It is the hope that model manipulation can reveal some small insight into ways in which girls can be encouraged to pursue this flourishing field. The overall objective of the study is to contribute to the growing effort to draw more girls and women into STEM.

2.2 Female Experience in the Field of Science, Technology, Engineering, and Mathematics Self-Efficacy

Although by all accounts there has been tremendous ground gained in female participation in the fields of math and science, girls and women continue to be underrepresented in the area of physical sciences, such as physics and engineering (Glass et al., 2013). As such, researchers continue to investigate both the reasons for the gap in participation as well as the means to inspire and sustain interest. The body of literature is extensive and has been synthesized in a number of ways. For example, Kahle and Meece (1994) reviewed the research on gender and science education from the 1970s through the early 1990s, focusing on the individual, sociocultural, family, and educational variables that contribute to participation and achievement. Brotman and Moore (2008) compiled the research on science and gender, especially as it pertains to equity and access, curriculum and pedagogy, the nature and culture of science, and personal identity. Others have extended their exploration to the feminist perspective of science education as well as the history of science education and how it has impacted female students (Barton, 1998; Brickhouse, 2001; Scantlebury & Baker, 2007). A common theme among the litany of literature is the possible detrimental influence of traditional pedagogical practices, which we must understand if we are going to change the behaviors of young women in the classroom.

The issue of classroom climate for girls draws heavily on the perspective that women learn differently than men and necessitates a change and expansion of traditional pedagogical practices. This approach draws heavily on the work of Gillian (1982), who showed that women's moral development differs from that of men and that women place more emphasis on relationships and connections. A common theme among the studies on gender-inclusive learning, spanning countries and ages, is the idea that girls are more relational and more cooperative than boys (Alexopoulou & Driver, 1997; Ferguson & Fraser, 1998; M. G. Jones, Brader-Araje et al., 2000; Zohar & Sela, 2003). Additionally, girls seem to desire a deeper conceptual understanding and are resistant to rote memorization (Meece & Jones, 1996; Zohar & Sela, 2003). Extensive work has highlighted that girls benefit from hands on and inquiry based learning (Burkam et al., 1997; Cavallo & Laubach, 2001; Heard, Divall, & Johnson, 2000; Lee & Burkam, 1996). Lee and Burkam (1996) used national achievement data for close to 19,000 eighth-grade students to show that girls', not boys', achievement in physics was positively related to in-class laboratory experiments. The authors subsequently argued that hands on learning experiences can promote gender equality in the classroom. Even though extensive studies have shown that gender inclusive instruction benefits both girls and boys (Ha¨ussler & Hoffmann, 2002; Lagoke, Jegede, & Oyebanji, 1997), there is an equally robust body of work showing that teachers have a limited knowledge of and experience with gender inclusive practices (Plucker, 1996; Zohar & Bronshtein, 2005) and show some resistance to gender inclusivity (McGinnis & Pearsall, 1998; Plucker, 1996; Zohar & Bronshtein, 2005). While some teachers may be actively resistant to gender inclusivity, others are not even cognizant of their own exclusionary practices. Sadker et al. (2009) observed hundreds of lessons in which teachers unconsciously allowed male students to monopolize classroom discussion, ask more questions, and receive more assistance and praise.

Experiences outside the classroom, particularly family influence, are equally if not more important. Work has been done demonstrating the important role parents' attitude plays in their children's self-perception and achievement behaviors (Bleeker & Jacobs, 2004; Bregman & Killen, 1999; Eccles, Wigfield, & Schiefele, 1998; Jacobs & Eccles, 2000). Pertaining to math and science, parent perception of their children's abilities as well as their own values about math and science relate to their children's subsequent achievement in those domains (Bleeker & Jacobs 2004). When girls take atypical educational routes, parents are often put forward as explanations (Dryler, 1998). By contrast, parents who perceive science to be a male oriented domain may be inadvertently contributing to gender inequity. Andre et al. (1999) found that as early as elementary school, parents perceived science as more important for boys and expected higher performance of boys. In a study of naturally occurring family conversation, Crowly et al. (2001) found that parents were three times more likely to explain science concepts to boys than to girls when engaging with interactive museum science exhibits. This pervasiveness of parental influence was also demonstrated by Bleeker and Jacobs (2004), who found that mothers' beliefs about children's future success in math-oriented fields was a precursor of children's career choices 12 years later, with this effect being only partially mediated by children's initial perception of their own abilities. As such, attitudes and beliefs of parents may be unintentionally contributing to a gender gap in children's scientific literacy and interest.

Further explanations pertaining to women’s under-representation in engineering and similarly related fields may be a consequence of occupational stereotypes and the traditional male domination in the fields. Women have been shown to sex-type science as a masculine pursuit (e.g., Hughes, 2002) and cast doubt on the utility of mathematics (Eccles, 1994). Fields of engineering are generally stereotyped as physically challenging, unfeminine, and aggressive (Adams, 2001), and are described as object oriented rather than people-oriented (Lippa, 1998). Women perceive the field of engineering as lacking in social responsibility and potentially further contributing to environmental problems (Hersh, 2000). This should be of particular note as women’s interest in relatedness and social improvement has been previously noted as a factor in their decision making. This cycle seems to be self-perpetuating as the dearth of women in engineering may propagate the perception that engineering is an uncharacteristic career for women (Byrne, 1993).

2.3 Social Cognitive Theory

The purpose of the study is to explore the manner in which manipulating the type of model to which students are exposed impacts their STEM interest and self-efficacy. In order to achieve this, it is first necessary to understand modeling and how modeling is situated in the construct of self-efficacy, interest, and subsequent career choice.

The origin of our understanding of modeling is rooted in Bandura’s social cognitive theory. The theory attempts to explain the relationship between individuals and their immediate environment, purporting that people do not mindlessly react to their environment but instead actively interact with their surroundings by seeking and acting upon information (Bandura, 1999). Previously, learning was viewed as sourced solely from consequences of one's own behavior, but Bandura highlighted that the tedious process of learning through trial and error can be made much more efficient through observation of social models (e.g., Luszczynska & Schwatrz, 2005). Bandura (1999) suggested that individuals "function as contributors to their own motivation, behavior, and development within a network of reciprocally interacting influences" (p. 169), meaning that people not only interact with their environment but also contribute to it and are drivers of their own outcomes.

Social cognitive theory offers a model of causation in the form of triadic reciprocal determinism. In this model of reciprocal causation, behavior, personal factors, and environmental influence all operate in a manner of bidirectional influence (see Figure 4). To put it more clearly, the three factors are in a state of constant reciprocal flow, exerting continuous impact over each other in varying degrees of influence. Schunk and Zimmerman (2007) offer the following example in the domain of writing: A student's behavior, such as selection of a topic or persistence in the task itself can be contingent on the surrounding environment (noisy classroom versus a serene one). Conversely, the social environment can also impact the student's behavior. A supportive teacher or a helpful peer may encourage the writing behavior or even persistence, lest the task becomes arduous. As such, the three variables work reciprocally, both influencing and being influenced by each other, thus highlighting the complexity of human behavior. In this way, we can observe the interlacing of factors that drive human behavior and consider the proposition that people aren't merely unwilling subjects of their environment but active participants in it.

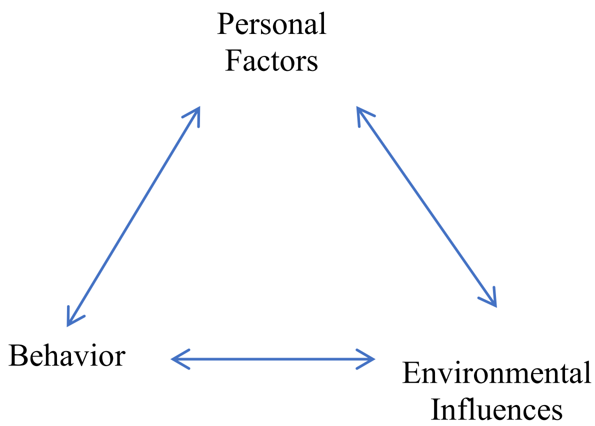

Figure 4. Model of causation from social cognitive theory in the form of triadic reciprocal determinism.

Because the three determinants are bidirectional, it makes it possible to aim efforts or interventions strategically. For example, if one wanted to improve student academic performance, strategies could be aimed at cognitive, emotional, or motivational processes or at altering the conditions under which students learn.

The social cognitive theory is applicable in the context of recruiting and retaining girls in STEM-related pursuits. Interested parties can work to improve students' emotional states and to correct their faulty self-beliefs and habits of thinking (personal factors), improve their academic skills and self-regulatory practices (behavior), and alter classroom structures (environmental factors) that may work to undermine their interest and possible pursuit of STEM (Pajares, 2002).

Because a pull on one of the levers may impact the others, this study is interested in observing the consequences of personal factors by manipulating the environment via the model. This will be done by the introduction of a new STEM social model to a student's academic environment.

Social models are fundamental to human development because people learn not only from personal experiences but also through observations of others. This type of vicarious learning allows the observer to learn a behavior without having to go through the tedium of performing it. Watching a model allows the observer to make decisions about the value of what they have just observed and make subsequent decisions about their personal behaviors. In that way, a social model can serve as a force of influence and possibly influence a future behavior pattern. Models can also impact personal factors, such as self-efficacy. Watching a model succeed may enhance confidence, whereas watching a model fail may abate it. As such, when examined in the framework of triadic reciprocity, the manipulation of the environment (model) may influence the STEM self-efficacy and interest of the student (personal factor), which may play a role in STEM course and possible career selection (Figure 5).

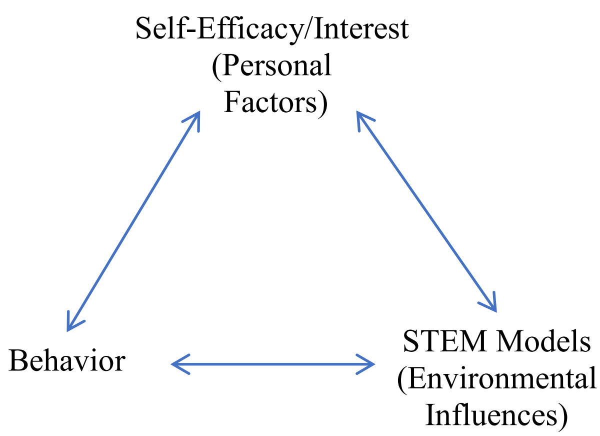

Figure 5. The framework of triadic reciprocity for the environment; science, technology, engineering, and mathematics self-efficacy/interest of the student; and behavior.

2.3.1 Self-Efficacy

Of all the beliefs that affect human functioning, firmly fixed at the core of social cognitive theory is self-efficacy (Pajares, 2002), or "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Self-efficacy is at the very source of human motivation, well-being, and personal attainment. This is because when people believe that their actions will produce desired outcomes, they have incentives to persevere when faced with difficulties or setbacks.

Consequently, self-efficacy beliefs impact how people think, feel, self-motivate, and subsequently behave (Bandura, 1977, 1986, 1994, 1997).

Four informational sources provide a frame of reference for this type of self-evaluation: mastery experiences, vicarious learning, verbal persuasion, and physiological states (Bandura, 1986, 1997; Wood & Bandura, 1989). Figure 6 provides a visual representation.

Figure 6. Self-efficacy sources of information. Adapted from “Self-efficacy: Toward a unifying theory of behavioral change,” by A. Bandura, 1977, *Psychological Review*, *84*, p. 191. Copyright 1977 by American Psychological Association.

Although this study seeks to explore the influencing power of models, the contribution of self-efficacy on behavior is so critical that each part of the construct will be reviewed. This is done in order to better contextualize the effect of modeling.

The first of the four factors of self-efficacy, mastery experience is by far the most salient. Past experiences are the most authentic type of feedback, and they provide evidence about the agent’s degree of competence. In other words, past successes indicate a degree of competence whereas past failures suggest a lack thereof. One can look back on a track record of success and feel supremely more empowered in her ability to complete a future, albeit, related task. While successes enhance self-efficacy, failures undermine it. Failure can be especially detrimental if it occurs before confidence in ability is fully realized (Bandura, 1995).

Task mastery is not without its shortcomings. Those individuals experiencing early success with little effort may have a miscalibrated sense of efficacy that can be easily undermined by an unforeseen challenge. A miscalibration in efficacy is a manifestation in which individuals accustomed to early successes may not have the coping mechanisms or problem solving strategies of those who have persevered over difficulties (Bandura, 1997). Challenges are key to efficacy development because they are more likely to provide learning opportunities and establish a more resilient sense of efficacy. Once resilience has taken root, failure is of less concern, as individuals can draw on past memories of success.

When considering the motivational implications of past mastery, a successfully accomplished task will result in an enhanced self-efficacy, thus increasing the likelihood of further task engagement (Bandura, 1993). As such, successes, self-efficacy, and motivation are in a constant self-propelling cycle, all susceptible to changes in environmental factors.

The second source of efficacy is vicarious learning; a point of particular interest, as it is the fulcrum of this study. Vicarious learning occurs when people observe others and learn a new behavior without having to undergo the trial and error process (Bandura, 1993). Social models allow for vicarious learning by modeling a particular behavior and consequently serving as a frame of reference for the observer (Bandura, 1995). Bandura's famous Bobo Doll experiment illustrates the concept (Bandura, Ross, & Ross, 1961).

If the models are similar to the observer, they can become agents of self-efficacy, meaning that in circumstances when models are similar to the observer and are engaging in behaviors the observer find desirable, the impact on self-efficacy is at its greatest (Schunk & Meece, 2006). The greater the similarity between the model and the agent, the more influential the model's successes and failures. This type of vicarious experience, however, is not nearly as effective as personal mastery, as it can be rendered null by a failed performance on the part of the model (Schunk & Meece, 2006).

Verbal persuasion is the third way of enhancing people's view of personal ability. A "you can do it!" statement can encourage effort and persistence (Bandura, 1995) but can be detrimental if encouragement is towards an unrealistic end and the efforts prove fruitless. False social persuasion can render the persuader untenable and diminish the agent's efficacy (Bandura, 1997). Negative verbal persuasion can also diminish feelings of efficacy and influence future decision-making. Girls whose mothers articulated a gender stereotype on their daughters' math and science ability by using negative statements impacted their children's achievement in math and significantly shaped future career choices. Even when controlling for ability, girls whose mothers held a negative perception of math competency based on gender did not favor the said subjects (Bleeker & Jacobs, 2004). Therefore, it is far easier to undermine self-efficacy with verbal persuasion than it is to enhance it.

Physiological and emotional states can also have a tremendous impact on an individual's willingness to engage in a task and her feelings about the likelihood of success. It is not so much the physiological and emotional state itself, but rather the interpretation of the feeling that is so influential on efficacy. Stress, fatigue, sweating, and a racing heartbeat can be debilitating or invigorating, depending on the mood of the agent, and as such have different types of influence on self-efficacy (Bandura, 1995, 1997). This is not difficult to imagine in application to ourselves. When we wake up feeling terrific, the prospect of facing the day, even a Monday, is much less daunting then if we wake up ill or simply feeling boorish.

Although the influence of self-efficacy is evidenced in a myriad of constructs and situations, how it pertains to female selection of math and science pursuits is the current subject of this study. Specifically, what impacts a female's self-efficacy as it pertains to math and science subjects, and how can that self-efficacy be engendered?

2.3.2 Modeling

Although not as salient as personal experience, modeling is a key attribute to the development or abatement of self-efficacy (Bandura, Blanchard, & Ritter, 1969). The work on modeling explores the roles of the social environment on personal attributes, motivations, and behaviors. In considering the aforementioned model of triadic reciprocity, modeling fits tidily under the umbrella of environmental influences and, as a result, has the potential to influence personal factors, such as self-efficacy and, subsequently, behaviors. Modeling works to govern behavior because an observer may pattern her thoughts, beliefs, and behaviors after those of the model (Bandura et al., 1969). The observer judges the information as pertinent or not and then acts accordingly. Consider the simple example of watching a car get pulled over for speeding. There is little need to experience the pleasure of getting a citation before deciding that slowing down might be in order. In this example, you as the driver observed the behavior pattern, evaluated the usefulness of the modeled behavior, and responded accordingly.

The utility of this is, of course, immense. The utilitarian usefulness of modeling serves as a valuable method for acquiring information about behaviors, attitudes, and beliefs for both adults and children (Rosenthal & Zimmerman, 1987). In other words, it is a very efficient way to learn without having to go through the hands on learning process. One does not have to pay a

$100 speeding ticket in order to curb any *Too Fast Too Furious* ambitions. Watching someone else do it is sufficiently informative. The learning occurs when a behavior is observed and then replicated.

Models can inform and motivate observers (Schunk, 2001) by providing the observer with a set of behavioral steps that may predict the observer's own success. Watching models provides the observer with probable outcomes for specific behaviors, especially when both successes and failures are demonstrated. As such, the observer does not need to personally engage in a behavior to experience the failure; it is sufficient to observe the consequence incurred by the model in order to decide that the behavior is undesirable. This results in vicarious learning. Consequently, observers can choose to mimic models whose behaviors have led to preferential outcomes. Little and Roach (1974) found that students who observed a successful model in a non-traditional occupation were more likely to perceive themselves as potentially successful in that field and expressed an inclination for pursuing that career. This was later supported by Greene, Sullivan, and Benyard-Tyier (1982) who showed that exposure to role models increased students' likelihood of pursuing a non-traditional career path. The research posits that role models may affect women's career decisions by demonstrating ways in which multiple roles can be negotiated or by persuading women that they are capable of handling multiple roles (Stickel & Bonett, 1991), such as navigating both domestic and professional domains (O'Brien & Dukstein, 1995).

Observational learning, or learning by observing a model, is a four step process: attention, retention, production, and motivation (Bandura, 1986). For observational learning to occur, one must first attend to the details in the environment. Retention occurs when observers store the modeled information in memory, organize, and subsequently rehearse the behavior.

Production is the application of the interpreted information into a behavior, such as the student setting up the lab experiment following the example of the teacher. Motivation impacts observational learning when the observer believes the model is in possession of useful or valuable information and is then more likely to attend to the behavior of the model.

Because learning from models, or observational learning, occurs as a function of observing and then replicating a new behavior, a crucial element in modeling is that the observed behavior must be new to the observer and not one that has already been performed prior to exposure to the model (Schunk, 1987). For instance, a student may watch a teacher set up a science lab and then replicate the exact task. Without the teacher model, the behavior on the part of the student would not have otherwise occurred. Self-efficacy is especially subject to malleability by an influential model when there has been little or no experience with the task in question (Gist & Mitchell, 1992).

Although vicarious learning has a weaker effect than performance based learning and is a less reliable source of efficacy than mastery experiences, people with little mastery experience or those who are uncertain about their capacities, are more sensitive to the effects of modeling (Bandura, 1977; 1997). The absence of knowledge about personal capabilities leads individuals to depend more heavily on the influence of the models (Usher & Pajares, 2008). Larson et al. (1999) investigated the impact on counseling efficacy of prepracticum trainees following videotapes of counseling sessions and role-plays with mock clients. Watching a videotape of a model conducting a counseling session provided modest but uniformly beneficial effects across all novice students.

Observational learning need not be limited to physically mimicking a task. Social behaviors, such as kindness, honesty, and fairness, can also be acquired through observation of others (Schunk & Zimmerman, 2007). My son has witnessed me returning things to a store clerk who forgot to charge me for them, as well as buying breakfast for a homeless person. Now that he is older, he often attempts to replicate these acts of kindness and morality, albeit sometimes inappropriately.

To be effective, models do not necessarily have to be observed in real time or face to face proximity. Symbolic modeling, in the forms of video or even imaging, can be just as effective. The omnipresence of television and other visual media allows us access to a broad range of diverse models and grants access to observe behaviors, attitudes, and achievements beyond the confines of our immediate surroundings, thus offering the opportunity for observing the unfamiliar (Bandura, 1997). Exposure to models, be they real or symbolic, who depict valuable skills and strategies can enhance the observer's confidence in her own facility (Kunce, Bruch, & Thelen, 1974; Schunk, 1987; Usher & Pajares, 2006; Zeldin & Pajares, 2000). This concept is illustrated by examining an effort to design better public service announcements and encourage people to help thwart drunk driving. Anderson (1995) tested the impact of two forms of symbolic modeling (demonstrating the behavior and describing the behavior) on intentions to prevent a friend from drunk driving. Anderson found that behavioral modeling registered the greatest effects. Anderson (2000) later conducted a similar study exploring the most effective ways to promote self-breast exams in young women. Participants in the study were either shown a video demonstrating how to perform a self-breast exam or a video imploring them to perform a self-breast exam. The modeling video engendered greater efficacy expectations and behavioral intentions than the persuasive video. The findings are consistent with predictions regarding the differential impact of types of models.

Models not only provide valuable information pertaining to present tasks but to future ones as well. Observing a model can be a method of self-appraisal, even for a task not yet attempted or a behavior not yet considered. A social model for a contemplated behavior can serve as a source of efficacy judgment for the observer and impact the level of interest and possible future participation in the said behavior (Bandura, 1997). This is evident in the Baker and Leary (1995) study about social modes. A subject in the study recalled that she had never contemplated studying zoology until she viewed the movie *Gorilla in the Mist.* The actress, Sigourney Weaver, who portrayed Dian Fossey, served as a model and directed the subject's interest toward the discipline. A point worth highlighting is that the subject in the study didn't need to see the real Dian Fossey to be intrigued by the discipline. Sigourney Weaver stepping in as a symbolic model appears to be equally effective. The implication is that that exposing girls to symbolic models of influence can be as influential as exposure to real scientists and mathematicians.

It is important to remember, however, that not all social models exert equal levels of influence or are similarly effective. People tend to learn from those models who resemble them closely or who match their ideal image (Bandura, 1986; Mussweiler, 2003; Schunk, Hanson, & Cox, 1987; Wood & Bandura, 1989). Consequently, different types of models exert different levels of influence. Using anthropomorphic avatars, Baylor (2009) found that when gender and ethnicity of the model matched that of the observer the influencing power of the model increased.

Considering the well-established research on the influential nature of models and the manner in which modeling, efficacy, and behavior, as illustrated by reciprocal determinism, are in a perpetual loop, it is important to explore whether model manipulation can be leveraged to enhance female self-efficacy in fields of STEM.

2.4 Social Cognitive Career Theory

Social cognitive career theory, or SCCT (Lent et al., 1994), is one perspective through which to explore the dearth of women in STEM. Rooted in Bandura's (1982, 1986) social cognitive theory, SCCT addresses the questions of how career interests develop from self-efficacy, how career choices are made, and how performance goals are achieved. The theory purports that self-efficacy is instrumental in determining the careers women choose, especially if the careers are not traditionally occupied by women. As a result, SCCT is used ubiquitously in the exploration of female participation in STEM.

Social cognitive career theory proposes that in addition to academic abilities, social factors contribute to the decision making process. According to the SCCT, person-input variables (such as math and science ability) determine a pupil's learning experiences (such as enrollment in high level mathematics and science courses), and that these learning experiences relate to academic and career choices in an indirect way. Those career choices are, in addition to other variables, mediated by self-efficacy, outcome expectations (expected consequences of behaviors), and interests (Bandura 1977; Lent at al., 1994). Based on Bandura's (1977) theory of self-efficacy, the model offers multiple pathways. Ability and positive learning experiences lead to greater self-efficacy, and ability, learning experiences, and self-efficacy are combined to lead to positive outcome expectations (Figure 7). Self-efficacy and outcome expectations "combine to facilitate the development of interests, which then [leads] to career choices and performance" (Nauta & Epperson, 2003, p. 449). Assessment of choices mediates subsequent self-efficacy and outcome expectations. As such, the model is cyclical in nature and longitudinal in scope (Lent et al., 1994; Nauta & Epperson, 2003).

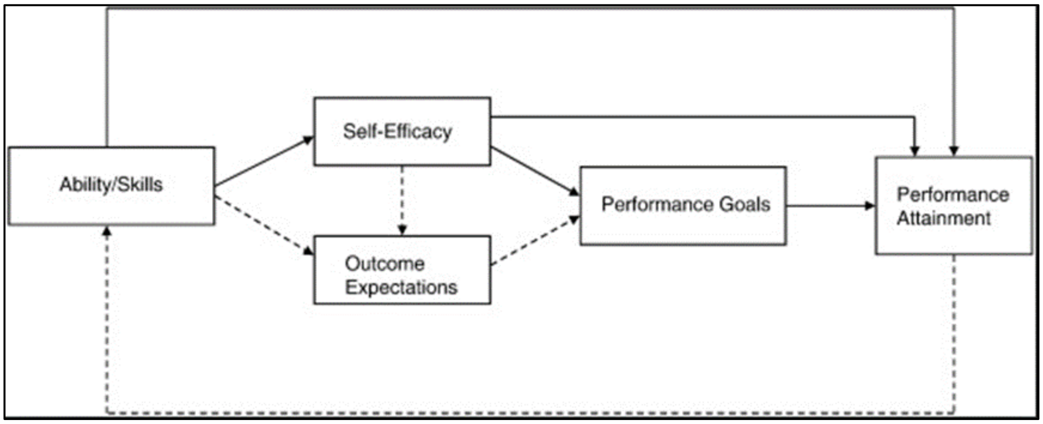

Figure 7. Ability and positive learning experiences.

Years of subsequent research, including a comprehensive meta-analysis (Hackett & Lent, 1992; Lent et al., 1994; Multon, Brown, & Lent, 1991), support the role of self-efficacy as a predictor of academic and professional preferences, academic performance, and the tenacity in pursuit of chosen vocation. However, the way individuals perceive socially constructed gender roles may lead to differences in self-efficacy with respect to certain professional domains, especially those traditionally dominated by males (Betz & Hackett, 1997).

The theory postulates a direct causal link between self-efficacy and interests, where changes in confidence lead to changes in interests (Bonitz, Larson, & Armstrong, 2010). Although there is ample evidence that these two constructs are moderately correlated (Rottinghaus, Larson, & Borgen, 2003), they are very much distinct, and this correlational research does not address the underlying issue of causality. The critical question in social cognitive career theory is the overlap of self-efficacy and interest, especially within a similar content area, such as STEM (Rottinghaus et al., 2003). As such, it is important to isolate the construct of interest from self-efficacy and explore it as an independent variable.

2.5 Interest

Although it is an affective variable like self-efficacy, interest is distinctly unique. There are numerous publications on both the definition and application of interest, as it pertains to an array of pursuits. There seems to be an implicit agreement in the publications that interest is a multidimensional construct, composed of both cognitive and emotional categories (Hidi, Renninger, & Krapp, 2004; Krapp, Hidi, & Renninger, 1992; Schiefele, 2009).

It is important to note that interest and ‘enjoyment while learning’ are not synonymous. Enjoyment can occur for a multitude of reasons, and interest is only one of these (Krapp & Prenzel, 2001). What distinguishes interest from other affective constructs is that interest is contingent on content specificity. Interest is “always directed toward an object, activity field of knowledge or goal” (Krapp & Prenzel, 2001, p. 30). One does not have general interest; rather, one is interested in something.

There is some debate on the relationship between attitude and interest; some suggest that that two are interchangeable. Schreiner (2006) argues that the boundary between them is still blurry, as neither of the constructs are related and not unidimensional (Hand, McDermott, & Prain, 2016), and suggests using both concepts synonymously. Conversely, Gardener (1998) impressed the point that the two are clearly distinguishable. Gardner argues that attitudes toward a subject are impersonal evaluations, whereas interest requires that subjective value be attached to the subject. For example, it is possible to have a negative attitude toward a topic (e.g., Brett Kavanaugh’s confirmation to the Supreme Court) but have a strong and enduring interest to study the topic (Hidi et al., 2004; Krapp & Prenzel, 2001; Krapp et al., 1992; Schiefele, 2009).

Osborne and colleagues consider *attitude* a unique construct that measures a “subject’s expressed preference and feeling towards an object” but do not link it to a particular behavior

(Osborne et al., 2003, p. 20). For instance, one might think that stars are very pretty and enjoy watching the night sky but has little interest in pursuing the study of astronomy. By their definition, *interest* is a contingency of attitude, limited to a specific object or domain, or in other words, *interest* is the action consequence of *attitude*. In their review of literature, Osborne et al. (2003) highlight methodological problems associated with measuring attitude and, to some extent, interest. They address, among others, issues of scale, concept definition, and variable selection. In the end, Osborne et al. (2003) decided that although "the concept of an attitude toward science is…nebulous…poorly articulated, and not well understood" (p. 1049), its understanding is a matter of importance and concern. As a consequence, studies on the subject frequently use interest and attitude interchangeably.

When it comes to reviewing the literature on the subject of interest, adhering to definitional purity is problematic. Because there is some debate on the distinction between interest and attitude (Krapp & Prenzel, 2011), and because it is frequently used interchangeably in the literature, this study will not attempt to distinguish the two and will not exclude research that confounds the concepts.

2.5.1 Interest in Science

An important aspect of the discussion on interest is domain specificity. The object or content area of interest can be described in a general way by referring to a broad area of knowledge, or by describing specific activities, tasks, or topics in which a person is interested in engaging (Krapp & Prenzel, 2001). Interest in science can be pared to either a general or a specific level. A more generalized interest in science could embody interest in a discipline related topic, whereas a more concrete interest in science could be limited to a particular school subject (e.g., biology, but not physics) or particular activities within the domain (e.g., graphing, but not dissecting). According to Krapp et al. (1992), a general interest in science can be seen as an enduring personal engagement in a topic. Interest in science as a school subject is both a combination of individual interests as well as a short-term interest directly related to the interestingness of the instruction and content. For instance, general interest in science can involve an individual subscribing to *Scientific American*, perusing museum exhibits, and committing to inquiry without an extrinsic motivator. In contrast, being interested in science as a school subject could be hinged on a particularly interesting lab experiment and expire at the end of the unit. One is potentially long term; the other potentially short term (Hoffmann, 2002). The two need not be mutually exclusive, as an interesting learning environment might stimulate situation interest that may result in long term individual interest.

A considerable amount of effort is put into identifying the distorted perception of girls' and boys' relation to science as well as the factors that evoke the differences between them. Interest, often mingled with attitude, is a direction for researchers pursuing an understanding of the difference between boys and girls. Generally speaking, boys' attitudes toward science have been seen to be relatively more positive than girls' (Dawson, 2000; Kahle & Rennie, 1993). Data from the 2009 National Assessment of Education Progress (NAEP) show that a higher percentage of males than females report that they liked mathematics or science by 4 and 10 percentage points, respectively. A meta-analysis covering the literature from 1970-1991 and examining the gender differences in student attitude toward science shows that not only do boys have a more positive attitude toward science but that in all cases, a positive attitude correlated with higher performance (Weinburgh, 1995). This pattern is not exclusive to the United States. Kotte (1992) collected data from students in 10 countries, reporting that the attitude toward science between male and female students widens as students progress from elementary to secondary school, with the most severe increase in gender difference occurring between the ages of 10 and 14. Girls' interest in science drastically declines in middle and secondary school, and girls are far less interested in the natural sciences than boys (Miller et al., 2006).

More recently, the 2003 Program for International Students Assessment (PISA) revealed that, in all participating countries, ninth grade male participants reported a higher interest in math (Preckel, Goetz, Pekrun, & Kleine, 2008). This behavioral pattern extends to varying ability levels. A study of 181 gifted and 181 average-ability sixth graders found that while mathematics related interest varied in males of different abilities, it did not explain the variance in attitudes for female students (Preckel et al., 2008).

Explanations for the variance in interest are aplenty. Boys, much more than girls, have early exposure to mechanical toys and are granted more opportunities to "tinker" and build (Kahle & Lakes, 1983). In contrast, girls reported having more experience with domestic activities, such as bread-making and knitting (M. G. Jones, Howe, & Rua, 2000). Additional, but by no means exhaustive, explanations suggest that parental expectations (Campbell & Connolly, 1987) and inequitable teaching strategies and science experiences in the elementary schools (Harlen, 1985; Kahle & Lakes, 1983; McMillan & May, 1979; Simpson, 1987) all account for the variability in interest between the genders. Because interest is a medium that contributes to the learning process (Nenninger, 1992; Schiefele, Krapp, & Winteler, 1992; Voss & Schauble, 1992), it is imperative to find out where and why the breakdown of interest in math and science occurs.

It is important to note, however, girls' disinterest in scientific topics is not all encompassing. There is variability among the disciplines, with boys' interest in physical science topics greater than that of girls, and girls' interest in human biology topics exceeding that of boys' (e.g., Ecklund, Lincoln, & Tansey, 2012). Students' perceptions of science carry over into their selections of science fair and research topics. G. Jones (1991) examined the topic selections of various science competitions and found that significantly more males competed with projects pertaining to the physical sciences, whereas girls' research was primarily concentrated in the biological sciences. Biology has traditionally been viewed by girls as a more caring branch of science, as it focuses on living organisms and has the potential to influence human health. Physics, by contrast, is often viewed by girls as pertaining to war and destruction (M. G. Jones, Howe et al., 2000). In a study of over 400 students, M. G. Jones, Howe et al. (2000) found that when interviewed about their respective science related interests, boys cited "planes, cars, computers, light, electricity, radioactivity, new sources of energy, and x-rays" (p. 20). By contrast, girls expressed interest in "rainbows, healthy eating, colors, animal communication, and AIDS" (M. G. Jones, Howe et al., 2000, p. 20). In the same study, male students listed a want to "control other people," "have an easy job," "become famous," "make and invent new things," and "earn lots of money," whereas girls wanted to "help other people" (M. G. Jones, Howe et al., 2000, p. 20). The stratification of science interest is similar among the gifted and the average ability: Gifted males show more interest in physics than do gifted females, whose focus of interest is inclined towards social issues, literature, and the arts (Lubinski & Humphreys, 1990). Archer, Lubinski, and Benbow (1996) conducted an empirical analysis from data collected over a 20-year period from over 1,000 intellectually gifted students and found that mathematically talented females are attracted to social consciousness (people dimension), which is negatively correlated with inorganic sciences. By contrast, mathematically gifted males are "theoretically oriented in their study values (things dimension)" (Preckel et al., 2008, p. 20).

In an effort to increase girls' interest in physics, Häussler and Hoffmann (2002) devised a unit centering on the use of safety helmets for cyclists. The leitmotif provided an effective backdrop for the intervention: Incorporation of a human-interest element and adoption of the curriculum to the interest of girls enhanced girls' interest and subsequent achievement in physics.

Baker and Leary (1995) interviewed 40 girls in an effort to determine what influences girls to choose science. Although the girls were highly self-confident and positive about science, they largely rejected the physical sciences because they did not see them as fields concerned with helping or caring. The girls distinguish "*scientist scientists"* in an effort to discern the physical from the biological sciences. When girls expressed interest in science related careers, they did so out of a desire to help people, animals, or the earth. The results suggest that for girls to be drawn to science, there needs to be a moral or relational component and that the models depicted and language used must also follow course.

2.6 Self-Efficacy and Science, Technology, Engineering, and Mathematics

As previously defined, self-efficacy (Bandura, 1977, 1997) is the individual's beliefs in her ability to perform a certain task or behavior. Self-efficacy is not a general quality or personality trait, but rather specific beliefs in reference to specific tasks or behaviors (Bandura, 1986). As a measure of personal confidence, self-efficacy has been shown to eclipse raw ability as it pertains to performance. Meaning that at an identical level of ability, differences in self-efficacy have been shown to yield different levels of performance (Wood & Bandura, 1989). For example, if two individuals of identical mathematical skill sat for an examination, it is possible that they would earn different scores if they had varying levels of self-efficacy towards the task. The individual with higher self-efficacy will outperform the person with lower self-efficacy, ability held constant. The field is rich with examples of this exact phenomenon (Bandura, 1994;

Bouffard-Bouchard, 1990; Chemers, Hu, & Garcia, 2001; Multon et al., 1991; Pajares & Johnson, 1996). Self-efficacy is a powerful construct because it is both highly correlated with performance, while simultaneously extremely malleable. Of course, self-efficacy alone is not alchemic, and to be successful, an individual must possess a certain level of skill in addition to high levels of efficacy (Bandura, 1986; Wood & Bandura, 1989). A person who has never piloted an airplane will not be able to do so successfully regardless of her efficacy toward the task.

In defining the construct, Bandura suggested that self-efficacy would influence in what tasks individuals engaged, the amount of effort put into those tasks, and individual tenacity in the face of difficulty (Bandura, 1977). The self-efficacy work germinated from Bandura's (1977) effort to ameliorate phobias but has of recent decades expanded to everything from the classroom to the office space to the sports arena (Brouwers & Tomic, 2000; Feltz, 1988). In the field of science education, self-efficacy has been used to explain college major selection and subsequent career choice (Dalgety & Coll, 2006; Lent, Brown, & Larkin, 1986, 1987, 1989; Luzzo et al., 1999) as well as achievement in science for high school (Britner, 2008; Lau & Roeser, 2002) and university students (Lent et al., 1984, 1987; Multon et al., 1991; Pietsch, Walker, & Chapman, 2003). These studies are part of an effort to explain why some students, especially women, persist in the study of science, while others do not.

The examination of students' self-efficacy in motivation and learning is extensive (Bouffard-Bouchard, 1990; Bouffard-Bouchard, Parent, & Larivee, 1991; Lent, Brown, & Hackett, 2002; Linnenbrink & Pintrich, 2003; Pintrich & De Groot, 1990; Schunk, 2003; Zimmerman, Bandura, & Martinez-Pons, 1992). Research suggests that self-efficacy influences motivation and cognition by affecting students' task interest, task persistence, and goal setting as well as their use of cognitive, meta-cognitive, and self-regulatory strategies. With regards to self-efficacy and academic achievement, studies have been conducted in a range of educational levels (e.g., primary, secondary, and tertiary), a range of subjects (reading, writing, mathematics, and computing science), and different ability levels (average, talented, and below average). These studies (Bouffard-Bouchard, 1990; Carmichael & Taylor, 2005; Lane, Lane, & Kyprianou, 2004; Pajares, 1996, 2003; Pajares & Miller, 1994; Relich, Debus, & Walker, 1986; Schunk, 2003) show the direct and indirect effects of students' self-efficacy on their achievements, relating to several grades and ability levels. The findings suggest that self-efficacy is both a predictor of and a mediator in achievement, motivation, and learning. Given this substantial role, it is imperative to gain insight into the development of students' self-efficacy and the ways in which self-efficacy can be mitigated or enhanced.

Matsui, Matsui, and Ohnishi (1990) used regression analyses to examine the contribution of the four sources to math self-efficacy (mastery experience, vicarious learning, verbal persuasion, and physiological feedback) in 97 male and 66 female Japanese undergraduates. They found that not only did men report a higher mathematics self-efficacy than women, but that gender contributed significantly to the regression model, while the four sources of self-efficacy did not. The authors interpreted the result to suggest that gender is a unique contributor to self-efficacy. These findings further suggest that in seeking explanations via self-efficacy, one should not ignore gender as a contributing factor.

Hackett and Betz (1981) offer another reason for using self-efficacy as a means for understanding male and female pursuit of the sciences. Hackett and Betz suggest that men and women appropriate and apply different types of information in their daily lives and that these influences can be used to explain the variability of career trajectories. The subsequent work of

Lent, Lopez, and Bieschke (1991) explored the relationship between the four sources of efficacy information to mathematics self-efficacy. They found that not only were efficacy sources predictive and helped explain gender differences pertaining to mathematics but that the development of self-efficacy varied for men and women. The differing sources of efficacy development were further examined by Zeldin and Pajares (2000).

Zeldin and Pajares (2000) explored the personal stories of women who pursued and excelled in the fields of mathematics, science, and technology to understand the manner in which their self-efficacy influenced their academic and professional trajectories. They found that when women recalled the various influences on their development and pursuits, the most salient ones were vicarious learning and social persuasion. When probed about the factors contributing to their career selection, the women listed family, peers, teachers, and supervisors as most influential. In a subsequent study Zeldin, Britner, and Pajares (2008) found that while men draw on mastery experiences to build confidence for STEM-related pursuits, women rely on relational episodes. The study further suggests that these sources of influence for women are more cogent in male-dominated fields than in otherwise traditional settings. The findings of these works suggest that the manner in which self-efficacy is developed and buttressed varies between the two genders and is a worthwhile lens for understanding the motivational differences between the genders in their pursuit of STEM-related majors and careers.

The factors contributing to disinterest in science are not always external to the agent and extend to include personal perceptions of ability (Betz & Hackett, 1983; Correll, 2001, 2004; Feather, 1988; Hargittai & Shafer, 2006; Hyde, Fennema, & Lamon, 1990; Sax, 1994). Correll (2004) found that despite on par performance with their male counterparts, women still tended to perceive themselves as less capable. The measure of what it means to be capable has also been shown to differ between the sexes. In a survey of engineering undergraduates, Concannon and Barrow (2010) found that men's persistence in the engineering program was contingent on their belief that they could successfully complete the program with any passing grade, whereas women's belief in success was based on their belief that they could earn an A or a B. The authors concluded that women held themselves to a higher academic standard and suggested that their self-efficacy predicted their persistence.

Calibration of one's perceived ability with her actual ability refers to the accurate understanding of one's competence and is relevant because confidence will catapult an agent into action. Individuals who are well calibrated will have a more precise recognition of their ability than those individuals who are miscalibrated. Miscalibrated individuals may either overestimate or underestimate their skill. Correll (2001) analyzed the National Educational Longitudinal Study of 1988 (NELS:88) database to measure the calibration of self-perceptions of mathematical competence to actual capabilities as pertaining to career decisions. Correll found that both men and women are miscalibrated in their perception of ability: Men overstated and women understated their own mathematical abilities. Correll concluded that the lowered self-perceptions of capability by female students constrained their career choices. This finding suggests that women's miscalibrated assumptions about their perceived limited abilities hinder them from mathematical and scientific pursuits.

The miscalibration of self-perception and ability begins to occur relatively early in the academic process. Pajares (2005) found that gender-based differences in self-perception began as early as middle school, persisting and increasing as students advance through school. Hutchison, Follman, Sumpter, and Bodner (2006) surveyed over 1,300 first year engineering students with respect to their self-efficacy. Seventy-two percent of female students compared to 55% of male students expressed concerns about their ability to meet the challenges of an introductory engineering course. Taking into consideration the aforementioned Concannon and Barrow (2010) study and the fact that women thought they needed an A or a B to be successful but men considered simply passing satisfactory, one may ponder whether girls and boys vary not only in their self-perception to succeed but in their estimation of success. The sentiment is best expressed by Farmer et al. (1995), who found that “in order to consider science careers, young women must be interested, efficacious, and academically qualified in science” (p. 20). Self-efficacy, and at a later point interest, are critical for female pursuit of STEM.

2.6.1 Impact of Modeling on Self-Efficacy

The influence of a model on individual self-efficacy is not uniform. The magnitude of influence is dependent on a variety of factors. One such factor is the similarity of the model to the individual. The weight of influence and imitative behavior is increased when the observer regards herself as similar, rather than dissimilar to the model. Rosekrans (1967) found that both the frequency of the imitation and the size of “the behavioral repertoire” were greater when model similarity was stronger. The importance of model observer similarity was confirmed by Kornhaber and Schroeder (1975) in their study on fear aversion in children. The study centered on exposing snake-fearing children to either child or adult models. Those children who observed a child model demonstrated a greater reduction in fear than those who viewed an adult model. Work on behavioral modification in the domain of fear reduction concedes that children experience a greater abatement of fear when exposed to peer models, possibly viewing adult figures as superior or more capable and thus rendering their behavior impossible to emulate (Thelen, Fry, Fehrenbach, & Frautschi, 1979).

Gender of the model proved to be an essential consideration in model influence. Perry and Perry (1975) found that children of either sex who identified as masculine recalled more of the male model's behavior than that of the female model. This was not mirrored in the children classified as feminine. The researchers suggested the social dominance of a male figure exudes more influence than a female. Consequently, a male model was of greater influence. Cook and Smothergill (1973) configured gender with race and found that in the presence of a White model, both Black and White children performed in accordance with the White model. The gender of the model, however, seemed to only impact the boys; the female participants were able to recall information equally well, irrespective of the gender of the model. In his 1987 review of literature on modeling, Schunk found no conclusive relationship between gender and model influence. Bandura (1997) explains the disconnection between gender and model influence as a task contingency. Specifically, "If the activity is not stereotypically linked to gender . . . functional value of the modeled skills can override the influence of the model's gender on observer's judgments of their efficacy" (Bandura, 1997, p. 20). Meaning that if the task is not encumbered by a gender linked stereotype, the significance of model gender is mitigated.

Research uniformly recognizes that seeing a person similar to oneself successfully perform a task increases an individual's self-efficacy beliefs towards the likelihood that she too can perform the task with equal skill (Schunk, 1986). This can work in the inverse as well. A model of great similarity who faces failure can diminish the efficacy of the observer (Bandura, 1981; Manz & Sims, 1981; Pajares & Schunk, 2001). The greater the similarity of the model, the greater the forces of influence.

Watching models struggle through a daunting task or articulate coping strategies can bolster the influence on personal self-efficacy. Coping models, or those who struggle through a task until achieving success, are more likely to engender self-efficacy than are mastery models, who achieve desired results without evidence of struggle (Usher & Pajares, 2008). What makes observing a coping model advantageous is the demonstration of overcoming a difficulty and gradually improving a performance. The aforementioned Kornhaber and Schroeder (1975) study assessed the effect of coping models and mastery models on children coping with a fear of snakes. Adult models handled snakes in either a fearful or fearless manner. The subject observing the fearful model yielded the greatest change in behavior. Schunk (1987) challenged the validity of the information, as the study did not measure self-efficacy. Schunk et al. (1987) investigated the influence of models on students exhibiting difficulties in mathematics. Children who observed coping models considered themselves more similar in ability to the models than children who had observed the mastery model. Additionally, children in the coping model groups demonstrated higher self-efficacy, skill, and training performance than those observing the mastery models. The benefit of the coping model over the master model is the perceived similarity between the subject and the model. Watching a model struggle provided the opportunity to observe both the difficulty and the coping strategies to overcome said difficulty (Meichenbaum, 1971). These studies reinforce the thought that model behavior can influence the efficacy of the observer.

A model’s persistence in the face of the challenge can also impact the personal efficacy of the observer. Zimmerman and Ringle (1981) showed that children who were shown adult models struggling with a complicated puzzle while simultaneously expressing statements of confidence had a significantly increased estimate of personal self-efficacy. This suggests that models who express confidence in the face of difficulty instill a greater sense of personal efficacy than models who convey a sense of self-doubt (Bandura, 1997).

Baron (1970) found that model-to-subject similarity (referred to in the study as attractiveness) and model competence influences mimicry. Undergraduate students interacted with models who were attractive (determined by apparent degree of attitude similarity between subjects and the model to the student) and judged their level of competence. For the undergraduate students, high levels of attraction promoted mimicry only when the model was highly competent but interfered with mimicry when the model was unsuccessful and suggested low competence. The competence of a model is an influential factor. Models who are competent carry a greater degree of influence, command more attention, and exert greater instructional influence than do incompetent ones (Bandura, 1986). Information revealing the competence of the model affected imitative behavior (Rosenbaum & Tucker, 1962).

2.6.2 Modeling as it Pertains to Interest

To explain the relationship between modeling and interest one need only to return to the work of Lent et al. (1994, 2000) and the social cognitive career model. A segment of the model purports that self-efficacy influences outcome expectations, which in turn influences interest. The authors suggest the following developmental trajectory: Over the course of childhood and adolescence, people are exposed to a wide range of social models that exemplify educational and professional possibilities. People also observe and hear about others performing various occupational tasks. Not only are they exposed (directly and vicariously) to an array of vocational tasks but they are “differentially reinforced for pursuing certain activities from among those that are possible and for achieving satisfactory performance in chosen activities” (Lent et al., 1994, p. 89). Through this repeated exposure of professional modeling as well as feedback from others, children and adolescents refine their ideas about personal performance standards, establish a sense of personal efficacy for task completion, and acquire certain expectations about their performance outcomes. The perceptions of self-efficacy and performance outcomes figure into their formation of interest. Phrased more concisely, people form enduring interests in activities in which they are both efficacious and expect a positive outcome (Bandura, 1986; Lent et al., 1989).

2.6.3 Modeling as it Pertains to Math and Science

The influence models exert over motivation cannot be overlooked and should be considered when evaluating the trajectory of math and science pursuits on the part of girls and women. Actively providing girls with relatable social models is a possible approach to ameliorating the deficit in their participation. Knowledgeable mentors in both academic and work settings can be important social models, serving as sources of encouragement (Ingram, Bruning, & Mikawoz, 2009) or enhancing an individual’s sense of competency and effectiveness (Kram, 1985). Modeling proves especially compelling, as social models have been shown to be imperative to girls’ STEM self-efficacy (Zeldin & Pajares, 2000). Stout et al. (2011) found that female students who were exposed to female STEM experts expressed more interest and greater STEM-related self-efficacy, and Trenor et al. (2008) found that women and minorities recurrently list models as influencing their decisions to pursue engineering as a major. Rosenberg-Kima et al. (2010) had similar findings when they explored the variability of race in science role models by using anthropomorphic computer characters to encourage Black and White undergraduate women to pursue a degree in engineering. Their findings reflected the axiom of modeling research: Computer based agents who matched the participants with respect to race and gender tended to be the most effective in improving the women’s responses to engineering-related fields.

In some instances, a social model need not perform any behavior at all; her mere presence in the field makes her worth emulating. In a collegiate setting, the presence of women on a math or science faculty can allow students to become acquainted with female role models, even if some are persons whom they do not wish to mimic. In a discussion on the critical loss of women in higher education science departments, a female interviewee commented that “Women are attracting women. The broadcasting of women-friendly environments through the grapevine [is a step forward]. Women are being empowered as women are increasingly a scarce commodity of departments seeking female faculty” (Etzkowitz, Kemelgor, & Uzzi, 2000, p. 113). As such, increasing the number of female social models in fields where women are historically underrepresented may serve as a means of abating this lack of representation going forward.

Zeldin and Pajares (2000) recognized the influence of teachers as models when they studied the self-efficacy and abilities of women with careers in mathematics, science, and technology. Through vicarious experiences and verbal persuasions, teachers, regardless of gender, who supported women in nontraditional fields served as influencing factors because of the “teacher’s enthusiasm for the subject matter and . . . the success of women in the male domains” (Zeldin & Pajares, 2000, p. 232). Interestingly, Zeldin and Pajares (2000) also reported that when it came to mathematics-related careers, peers were less influential than family members and teachers. This phenomenon may be related to the perceived expertise of the model. Because students may consider adult models to be more knowledgeable on the subject of vocational pursuits, they may prefer adults as sources of information over their peers. This reflects the theoretical suggestion that models deemed knowledgeable are more influential sources than those deemed not (Pajares & Schunk, 2001).

Nauta et al. (1998) explored a model of predictors of career aspirations for two types of female students: women in mathematics, engineering, and physical science majors and women in the biological sciences. They found that women who have been influenced positively by role models are more likely to believe that math, science, and engineering careers are compatible with family and other domestic responsibilities, a belief that is associated with high level professional aspirations in these fields. In contrast to the women in math, physical science, and engineering majors, the effects of self-efficacy and positive role model influence are significantly lower in magnitude for women in biological sciences. Lopez del Puerto, Guggemos, and Shane (2011) investigated strategies for recruiting and retaining women in construction management education for the purposes of assisting construction management programs in increasing their female population. The authors suggested that programs include a formal mentoring program to match students with female faculty members or peers. The key point was that female role models and mentors can provide guidance and support to female students.

Although the research on the benefits of modeling is broad in scope, researchers are still exploring what types of observational learning—live models, videotaped models, participant models, etc.—are most effective. When the discussion pertains to transitioning models into a source of efficacy, questions about the most ideal modeling conditions are still open for exploration (van Dinther et al., 2011).

Additional research on college age students has found that interaction with female peers in a math subject significantly increases positive attitude towards math and greater identification with math (Stout et al., 2011). While the presence of a female professor increased voluntarily answered questions by female students from 7% to 46%, the female students were significantly less confident in their abilities when they had all male professors, despite, on average, achieving higher grades than their male counterparts, regardless of professor gender (Stout et al., 2011).

In another example, feminine female STEM role models presented from the perspective of a written magazine-type interview to middle school students have been shown to significantly decrease current interest in math, self-rated ability, and success expectations (Betz & Sekaquaptewa, 2012). Feminine traits were experimentally manipulated to include clothing choices (pink vs dark colors) and hobbies (reading fashion magazines vs reading). The same results did not cross over to feminine female models who were presented as generally successful at school without a specific STEM focus (Betz & Sekaquaptewa, 2012), indicating that the feminine cues specifically were not driving negative outcomes. Follow-up studies showed that the combination of femininity and success in STEM seemed particularly unobtainable and particularly discouraging to female students who did not initially like STEM (Betz & Sekaquaptewa, 2012).

Although there is very little research directly exploring the relationship between STEM self-efficacy or STEM career interest and role model manipulation, these studies provide evidence that small changes in role models may have dramatic effects on interest in STEM, perceived ability to succeed in STEM, and engagement with STEM subjects. By exploring unconventional methods of self-efficacy enhancement, particularly for young women interested in pursuing careers in the STEM fields, this study hopes to find clues to encourage female entry into STEM careers.

2.7 Self-Image of Scientists and Mathematicians

As previously suggested, disinterest in the physical sciences on the part of girls and women may germinate from an array of factors that originate in early childhood. The messages about science, as well as representations of scientists, solidify a perception that persists and influences future choices about science related courses and careers (Knight & Cunningham, 2004). While most children do not typically come in contact with actual scientists, perceptions of scientists are formed through exposure to pop culture, such as books, movies, televisions shows, cartoons, video games, and a variety of other sources. The images of scientists that children encounter during the formative stages of development contribute to the shaping of perceptions of scientists and ultimately influence subsequent academic and career related choices (Steinke et al., 2007). The salience of these social models is of particular importance to adolescent girls as they contemplate future occupational interests. If girls do not envision science related careers as compatible with their feminine perceptions or as appropriate for women because of the existing masculine gender stereotype, their interest in science may be compromised. If the traits associated with scientists are male-typed, girls may feel reluctant to pursue the field (MacCorquodale, 1984). Rossi (1965) noted four characteristics of eminent scientists: high intellectual abilities, intense channeling of energy into a singular direction, extreme independence, and social separation. Rossi suggested that this set of skills is incongruent with traditional sex roles attributed to femininity and keeps girls and women from pursuing science, engineering, and medicine. Although it has been noted that medicine is no longer a field underrepresented by women, engineering is still very much a male-dominated domain. The character traits associated with science *per se* are linked with masculine characteristics, and as there are girls who prefer to adhere to more traditional views of feminine behaviors, women may continue to be disinclined in their pursuit of science. Recent studies that focus on girls' declining interest and attitude in science (Miller, Slawinski Blessing, & Schwartz, 2006; Weisgram & Bigler, 2006) echo this sentiment. When examining the gender difference in attitudes toward science, Miller et al. (2006) found that girls as well as boys "see scientists as loners who have little time for their families or friends because they work long hours in a laboratory on problems that have little obvious relevance to people or social problems" (p. 377). These traits may hold little appeal for individuals who value collaborative work environments or social interactions.

The common stereotype of the mathematician or scientist is neither feminine nor favorable. In Chambers' (1983) *Draw a Scientist* (DAST) study, 4800 school children were asked to illustrate their perception of a "scientist." The results were coded for a number of variables, including lab coats and eyeglasses, but it was the gender of the hypothetical scientists that proved to be most startling: Of the nearly 5,000 student participants, only 28 girls and no boys drew a female scientist. The DAST study has been repeated multitudes of times with numerous variations (Finson, Beaver, & Cramond, 1995; Fort & Varney, 1989), but each one echoed similar results: For the most part, a scientist, as imagined by a child, is White and male. The perception is not limited to the younger grades. Barman (1997) found that older students were less likely than younger students to draw a female scientist, and in a study of undergraduate biology majors, Rosenthal (1993) noted that while both male and female students drew more male scientists, only female students drew female scientists. This cannot be too surprising. Scientists in media have almost always been exclusively male. *Mr. Wizard, Bill Nye the Science Guy, and Sid the Science Kid* all have male characters at the helm. The female scientists who do make it to mainstream television consist of *Big Bang*'s Dr. Amy Fowler, who is cold, calculating, emotionally withdrawn, and socially awkward and Dr. Winkle, who comes equipped with black framed glasses and a lazy eye. The "nerdy, male, and White" stereotypes of scientists can be off-putting for girls (Eisenhart, Finkel, & Marion, 1996), and the few female models presented by mainstream media are hardly worth emulating. To pursue and persist in a scientific track, girls must be able to visualize themselves as future scientists (Baker & Leary, 1995). Visualizing oneself as a future scientist can prove difficult, as academic textbooks and children's literature are virtually devoid of female role models (Sadker, Sadker, & Klein, 1991) and media models are, at best, highly problematic.

The negative perception of scientist seems to be ameliorated when girls are provided with positive role models. When interviewed about a female scientist who made a lasting impression, a student in Baker and Leary's (1995) study cited *Gorillas in the Mist.*

> When I saw Gorillas in the Mist. The movie? When I saw her working with the animals and saving them she just, like, became my hero. I really admired her for that and I want to do that too, so that clenched it. I like, knew right then that I wanted to. But all my life I just, I loved animals, you know, but I didn't know I wanted to make a career out of it. (p. 114)

Additionally, Baker and Leary (1995) reported that when girls had close friends or family engaged in the sciences, they had a more positive, less stereotyped view of science and science related careers. Another interesting finding came from Updegraff, McHale, and Crouter (1996), who found that girls from egalitarian households, where both parents were employed and equally participated in household duties, were less likely to show a drop in mathematics and science related scores.

Previous research has shown that even small changes in role models can affect female perception of STEM self-efficacy and perceptions of an individual's own abilities to succeed in STEM subjects. For example, research by Cherian et al. (2011) found that women who interacted for less than 2 minutes with STEM models embodying non-stereotypical STEM traits had significant improvements in how they perceived their own ability to succeed in a STEM field. The experimentally manipulated differences between the stereotypical and non-stereotypical models were altered changes in clothing (T shirts with a coding reference vs plain color), altered favorite movies (Star Wars vs. American Beauty) and altered hobbies (playing video games vs playing sports), among other small changes. These findings suggest that the presence of relatable models may influence girls' attitudes towards science as well as prospective careers in the field.

2.7.1 Manipulation of Self-Efficacy: Messaging and its Impact on Girls in Science

So what kind of a social model is desirable to encourage girls to pursue STEM? According to existing research discussed in earlier sections of this chapter, in order to be relatable, a model must be competent as well as somewhat similar to the observer. But what other variables, those less explored, have been left out of the literature? If dorky and average looking TV female academics are not appealing models to women and do not represent traits desirable for parodying, would an aesthetics upgrade to the model make her more salient and influential?

One place to look is at the concept of beauty, which is a central theme in our social environment, with media extolling the virtues of the young and pulchritudinous. While our appreciation of beauty litters all forms of literature and media, we simultaneously preach maxims of the frivolity of physical beauty, stressing that beauty is only skin deep and that judging a book by a cover is an unfavorable approach to an accurate assessment. Although this suggests a tension, empirical evidence illustrates that as much as we would like to believe we are impervious to beauty, we are, in fact, its willing subjects. Not only are we drawn to physical beauty, we are willing to attribute characteristics of goodness and virtue to those whom we find aesthetically pleasing (Dion et al., 1972). The 1972 "What is Beautiful is Good" study (Dion et al., 1972) posited and confirmed that attractive people are not only judged more favorably, but are expected to have a higher quality of life, more prestigious occupations, better parenting skills, and highly attractive spouses. The social perception and stereotype of attractive people is that they simply have a better standard of living. The "What is Beautiful is Good" stasis has since been confirmed, asserting that attractive people are perceived to be happier, healthier, better adjusted, and generally more successful (Dipboye, Arvey, & Terpstra, 1977; Dipboye, Fromkin, & Wiback, 1975) and consequently are the beneficiaries of disproportionately favorable treatment (Hamermesh & Biddle, 1994).

The advantages heaped upon the pulchritudinous are well documented, including political candidate selection (Efran & Patterson, 1974; A. C. Little, Buriss, Jones, & Roberts, 2007), grade inflation and teacher interactions (Clifford & Walster, 1973; Gordon, Crosnoe, & Wang, 2014), professional opportunities (Hamermesh & Biddle, 1994), and legal consequences (Gunnel & Ceci, 2010; Sigall & Ostrove, 1975). Even infants, ignorant of social constructions of beauty, are more inclined toward the beautiful than the not (Langlois et al., 2000). In a comprehensive review of literature on the subject of beauty, Langlois et al. (2000) found that, to put it simply, attractive people are judged and treated more favorably.

Whether our perceptions of beautiful people are accurate is irrelevant. An axiom of modern social psychology is that people's interpretation of their surroundings is highly resistant to social reality (Jussim, 1991). That is to say, individuals construct their own social perceptions, even if those perceptions are unsupported by fact. Consequently, the stereotypes we hold about beautiful people evolve into social truths. Our perception that attractive people are socially better off (Dion et al., 1972) is solidified into fact, even in the face of counter claims (Johnson, Podratz, Dipboye, & Gibbons, 2010). It is then of little consequence whether an attractive person we encounter is happy, healthy, or wealthy. If we believe them to be, then it must be so (Jussim, 1991).

Another method of extrapolating information based on an unrelated attribute is referred to as the "halo effect" (Nisbett & Wilson, 1977; Thorndike, 1920). Christened by Edward

Thorndike in 1920, the halo effect demonstrates our tendency to judge people in general terms and then extrapolate “judgements of [other] qualities by this general feeling” (p. 20), suggesting that if we like a person, we are apt to assume that other attributes of their personality, on which we may have little to no information, are positive as well. This suggests that if we find someone to be nice, we may also assume that they are smart, just, charitable, or possessing myriad positive personal attributes, even if there is no evidence for the assumption. Empirical evidence came in the form of military evaluations. Officers were asked to evaluate their subordinates on physical qualities, personal qualities, intelligence, and leadership. The correlations were so “high” and so “even” that Thorndike (1920) concluded that even “a very capable [person]… is unable to treat an individual as a compound of separate qualities and to assign a magnitude to each of these in independence of the others” (p. 28-29). It is then not beyond the scope of possibility that an encounter with an attractive individual leads to positive judgments on other realms of their life (Albright, Kenny, & Malloy, 1988; Dion et al., 1972; Wade, Loyden, Renninger, & Tobey, 2003). Because attractiveness matters, it will be a critical feature to test in our study of models.

2.7.2 Gendered Language

Implicit in the social cognitive theory is the role of environmental influences. An often overlooked element in the environment is the role of language. This is particularly pertinent because of recent advances in current understanding of the role that gendered language plays in the role of female pursuit of male-dominated fields. Explanations anchoring on gender or feminist perspective argue that educational and professional segregation is reflective of established culturally stereotypical norms (Anker, 1997). These stereotypical norms pertaining to men and women, and subsequently masculine and feminine jobs, are developed in early childhood and continue through adolescence, adulthood, and old age (Gottfredson, 1981; Porfeli, Hartung, & Vondracek, 2008). In this developmental trajectory, children in the age span of 6 to 12 make salient discriminatory judgments between occupations and activities that they like and dislike (Gottfredson, 1981) which can persist long into adulthood and impact their vocational choices (Seligman, Weinstock, & Heflin, 1991; Trice & McClellan, 1994). This perspective suggests that occupational selection can be rooted in children's perceptions about occupations. Consequently, inaccurate associations and gender-oriented perceptions learned in early childhood can cause children to prematurely narrow their interests and subsequent occupational choices (Vervecken, Hannover, & Wolter, 2013). An important input into such early learnings is gender-oriented language.

It has recently been demonstrated that as children grow up, the manner in which gendered language is utilized, especially as it pertains to occupations, can become ingrained (Liben, Bigler, & Krogh, 2002). Vervecken et al. (2013) tested the premise that children's perceptions of stereotypically male jobs can be influenced by presenting the occupation in both masculine and feminine form (e.g., *firemen* are people who extinguish fires; *firemen* and *firewomen* are people who extinguish fires). They found that when the occupations were presented in pair form (*firemen* and *firewomen)*, female subjects expressed greater interest in stereotypically male occupations and the pairing influenced the way both boys and girls perceived these occupations. The impressions formed in formative childhood periods, be they stereotypical or not, persist through adulthood, influencing men's and women's perceptions of occupational pursuits (Gaucher, Frisen, & Kay, 2011).

Because language is a means through which gender stereotypes are transmitted (Liben et al., 2002), when it comes to women contemplating a career in traditionally male-dominated fields, it is plausible to consider that the use of gendered language in job descriptions or advertisements can trigger a previously learned stereotype and hinder the interest, accessibility, or pursuit of that particular field (Bem & Bem, 1973; Gaucher et al., 2011; Vervecken et al., 2013). As such, exploration of gendered language in the professional domain may yield a promising explanation for educational and professional gender segregation.

In the first of these studies, conducted over 40 years ago, Bem and Bem (1973) explored the manner in which job advertisements that explicitly expressed a preference for male applicants discouraged women from applying. The study exposed subjects to three types of advertisements: sex-biased (i.e., explicitly referenced men as candidates for traditionally male jobs such as linemen and women as candidates for traditionally female jobs such as stewardesses), sex-unbiased (i.e., referenced both men and women as candidates), and sex-reversed, intended to appeal to persons not normally recruited for the position (i.e., referenced women for traditionally male jobs and men for traditionally female jobs). The results were unambiguously clear: Women were disinterested in jobs listed in the sex-biased advertisements but were likely to apply to male-dominated jobs when the advertisements were unbiased. Women were most interested in traditionally male jobs when the advertisements were sex-reversed, explicitly referring to women as the preferred candidate.

To some degree, this type of study is not applicable to contemporary hiring practices. The U.S. civil rights legislation (Title VII of the 1964 Civil Rights Act) disallows explicit preference for a gender as it pertains to job recruitment. Consequently, recruitment and job advertisements abandoned explicit requests for men or women or the use of genders specific pronouns, such as *he* or *she.* This, however, did not completely eradicate the problem. Although blatant gender biased recruitment is a non-practice, it is possible that the gender of a preferred candidate is still conveyed, albeit through more subtle phrasing; diction choices in advertising may convey information suggesting that a particular job is best suited to a particular gender (Gaucher et al., 2011). For example, a job looking for an aggressive candidate who likes to win may prefer a male applicant, versus a job looking for a collaborative and empathetic team player.

Subtle gender cues in advertisements were explored by Born and Taris (2010) who examined whether students' inclination to apply for a job was influenced by the wording of an employment advertisement. They discovered that female students were more likely to express interest in jobs listing stereotypically feminine characteristics, such as collaboration or teamwork. By contrast, male students were not impacted by a job's profile, be it stereotypically male or female. The study makes plausible the assumption that gender cues within an advertisement commands who applies for the job, especially if one sex is more sentient of gender stereotypes. The use of gendered language, whether intentional or accidental, perpetuates a segregated workforce by encouraging people to follow aspirational pursuits in line with traditional gender-linked stereotypes and consequently discourages people, especially women, from pursuing non-traditional professional roles.

A most recent, and highly publicized, study conducted by Gaucher et al. (2011) exhaustively examined the impact of gendered wording in job recruitment materials. In a series of 5 studies, the authors explored institutional levels of inequality and suggested that gendered language is so institutionally ingrained in the way business is routinely conducted that it is simply overlooked and may be completely unintended. Study 1 demonstrated that recruitment materials for male-dominated jobs contained more masculine language, such as *competitive, dominant,* and *leader,* than did materials for female-dominated jobs. Approaching this in a different context, Study 2 found that advertisements posted within male-dominated departments (i.e., engineering, math and computer science, business and economics, and accounting and financial management) contained more masculine diction than did advertisements posted in female heavy departments (i.e., applied health studies, arts, environmental studies). The implication of masculine wording was explored in the subsequent studies. Study 3 revealed that when advertisements were dominated by masculine diction, participants perceived those occupations to be dominated by men and, more importantly, the jobs were less appealing to women (Studies 4 and 5). Such procedures, deliberate or not, have a discriminatory effect. Highly masculine wording may mitigate female interest in professional pursuits, suggesting not that they are not capable of succeeding in those pursuits, but simply that they do not belong.

One way to palliate the continued underrepresentation of women in male-dominated fields is to consider not only the particulars of the jobs themselves or the skills required for the jobs but also the discourse used when those jobs are described. Experimental data suggest that replacing masculine terms with more feminized wording increases women’s interest in those fields (Gaucher et al., 2011), suggesting that minor changes in diction could yield important social change.

2.8 Additional Variables of Exploration

Although language, gender, attractiveness, and human element were the central variables of interest, it would be negligent not to consider whether some variation in student demographic interrelates with those variables. It is therefore worthwhile to examine some tangential elements that may further enrich the understanding of female interest and efficacy in STEM, specifically birth order, presence of a STEM parent, math and science high school course selection, and post-secondary plans.

2.8.1 **Birth Order**

Research has shown that a child's environment has a deep and lasting impact on his or her cognitive, emotional, and social development (Holmgren, Molander, & Nilsson, 2006; Leman, 2009), acknowledging that overall development is shaped and formulated by variables within the home environment, such as quality of parenting and available resources (Downey, 2001). Downey (2001) further stated that "one of the most consistent predictors of educational outcomes is the number of siblings" (p. 497). As such, the importance of sibling relationships and impact of birth order cannot be overstated.

Birth order remains simultaneously a highly researched and a highly controversial topic, with many claiming no relationship between birth order and social or cognitive development (Herrera, Zajonc, Wieczorkowska, & Cichomski, 2003). The literature illustrates that the climate in which a child spends his or her childhood has a lasting impact on intellectual development (Holmgren et al., 2006), and several studies have shown the relationship between firstborns (and only children) and achievement—in terms of both careers and academics (Carette, Anseel, & Yperen, 2011; Kantarevic, & Mechoulan, 2006). With that in mind, one must consider whether birth order may exert other forces of influence, such as those relating to STEM interest, efficacy, and possible pursuit.

2.8.2 **Parent in Science, Technology, Engineering, and Mathematics**

Parents' internal beliefs about their role in their child's education impact not only the degree to which they participate in that educational process, but on the child's academic outcome as well (Grolnick, Ryan, & Deci, 1991). Parent involvement has been attributed to a multitude of positives, including lower dropout rates, greater levels of on-time high school graduation, and increased levels of participation in advanced-level courses (Barnard, 2004).

Parent influence on a child's academics may not necessarily have to be a conscious decision. This is illustrated with a concept Archer, DeWitt, and Willis (2014) coined *science capital* as a means of describing different family behaviors, resources, skills, and general knowledge as it pertains to science education. The stipulation was that families with higher science capital are, to a greater extent, more involved in STEM activities, spend time discussing STEM topics at home, and provide their children extensive out-of-school STEM activities. As a result, those families rich in science capital can "produce values, attitudes, expectations, and behaviors . . . that promote academic attainment" (Archer, Dawson, DeWitt, Seakins, & Wong, 2015, p. 924).

Another way in which parents can influence their children's attainment in STEM is by communicating the value of STEM-related domains. Parents who believe that STEM is beneficial may direct a child toward a STEM-related activity or can influence a child's perception of STEM by discussing the utilities of the math and sciences (Harackiewicz, Rozek, Hulelman, & Hyde, 2012). These findings are not uniform across the literature. While some studies do indeed show that parents' perception of STEM is related to a child's interest (Eccles & Jacobs, 1986; Frenzel, Goetz, Pekrun, & Watt, 2010), other work found no such relationship (Harackeiwicz et al., 2012). With this in mind, one may posit that a parent involved in a STEM-related career may transmit the value of a STEM-related education and a possible STEM-related career and may, in turn, influence a child's interest and efficacy.

2.8.3 High School Course Selection

The degree to which students are interested in STEM-related fields and jobs shapes their selection of math and science classes and their performance in those classes (Lichtenberger & George-Jackson, 2013), thus affecting their degree of preparation for a possible STEM major.

The level of preparation, in turn, impacts the students' entry into a STEM major, as well as their persistence in that major and likelihood of degree completion (Elliott et al., 1996). A high level of academic preparation is not an uncommon characteristic of students who pursue STEM majors in college (Levine & Wycokoff, 1991). Taking a heavy load of science courses has shown to increase students' declaration of Engineering and Physical Science majors in college (Ethington, 2001), while an enhanced math course load with "academically intensive . . . courses-trigonometry, pre-calculus, calculus" (Trusty, 2002, p. 471) improves the likelihood of women choosing a STEM major in college.

High school course taking, particularly in science, was significantly and positively related to an increased likelihood of having an early interest in STEM. Moreover, both participating in AP science and taking more science courses significantly increased one's odds of having an early interest in STEM, meaning advanced courses taken in math and science at the high school level provide a viable avenue to attaining a degree in STEM (Tyson, Lee, Borman, & Hanson, 2007) . Given this fact, advanced math and science courses taken in high school may lead to a mediating factor of early interest in STEM, which may subsequently impact STEM degree completion. This relationship should be explored.

2.8.4 Post-Secondary Plans

The role of two-year post-secondary institutions in the education of STEM majors is an important pathway to STEM degrees (Horn, Neville, & Griffith, 2006). The influence of these institutions on the nation's STEM education pipeline is highlighted in a report based on the National Science Foundation (NSF) 2001 National Survey of Recent College Graduates (NSRCG) which found, on average, that 44% of science and engineering graduates attended a community college. The findings clearly substantiate the assertion that community colleges will have considerable future influence on the landscape of STEM education. Community colleges make a notable contribution to the increase of STEM graduates: One-third of master's degree and 8% of doctoral degree recipients, and approximately 25% of natural sciences, biological sciences, and physical sciences majors attended a two-year institution as their first institution (Chen & Weko, 2009; Tsapogas, 2004). These trends position community colleges as integral pathways for students to prepare to enter the STEM workforce.

The challenge of increasing the presence of women in STEM careers opens the doors for community colleges to play an important role in the recruitment and education of women as they select their post-secondary institutions. As of 2008, 58% of women attended community colleges as their first post-secondary institution. STEM degree recipients mirror the same community college attendance trends (Malcolm, 2010; Tsapogas, 2004). The unanswered question is whether high school students recognize community colleges as potential pathways to a STEM career and whether those who indicate an interest and efficacy in STEM would consider utilizing that particular pathway.

2.9 Concluding Thoughts

The purpose of this study is to understand how variability in models and messaging influences interest and self-efficacy in science related pursuits. Furthermore, this study will explore the role model and subject gender, gendered language, and inclusion of a human interest component and their impact on STEM interest and self-efficacy. It is the hope that by better understanding how to make models in STEM fields more attractive to women, the academic, business, and government communities can be more cognizant of what kind of STEM models they present and the discourse they use to discuss the field.

Studies of self-efficacy, or the confidence in one's ability to succeed in a task, have thoroughly established the link between student persistence and success in various fields of science and mathematics. We also understand the important relationship between interest and self-efficacy. Further, significant depth of work has been done to demonstrate the impact of models on self-efficacy. What is not known are the best ways to manipulate those models to drive to a particular outcome. In this case, will models of a particular attractiveness, supported by properly gendered language, and with the proper human impact context encourage more girls to study in STEM programs and pursue careers in STEM fields?

The results of this study, should a relationship between language and attractiveness in models be established, could result in specific actions to increase the number of women STEM. For example, if a strong sense of what sort of models inspire young women to persist in STEM studies, the academic community could be more conscientious of the scientists they include in the textbooks and the language they use to describe the said scientists. Such understanding could also help media bolster the number of women in STEM. For example, armed with a sense of the "ideal" model for young women in STEM, scientific television programming aimed at young people, such as the PBS show "SciGirls" could ensure their cast represents the best models for impacting self-efficacy. Finally, the business community, looking to increase their diversity and inclusion as well as to ensure the maximum number of qualified applicants apply for a given position, could tailor their recruiting images and language to drive participation from women. In other words, understanding what makes a model an effective determinant of self-efficacy for women in STEM could lead to tangible actions to the benefit of academia, media, and businesses at large while concurrently benefitting women and the economy as a whole.

It is important to note that if no relationship is found, the study will not be in vain. At present, there is very little evidence supporting or refuting this hypothesis. The more work that is done to try and define specifically what is needed to improve self-efficacy in women so that they persist in STEM fields, the sooner the efforts made to close the gap can be more successful.

3. RESEARCH METHODOLOGY

This chapter will present a description of the research design and the methodology, including subject recruitment and data collection procedures. This will be followed by an introduction to the instrument used in this study, operationalization of constructs, and the data analysis plan. Discussions of threats to validity, ethical procedures, and a summary will conclude the chapter.

3.1 Overview

The main purpose of this study was to explore the relationship between STEM self-efficacy and STEM career interest with five independent variables: gender of the student (male or female), attractiveness of the model (attractive or average looking), use of gendered language (male or female gendered language), a human interest context to the STEM biography (no human interest context or a human interest context), and gender of the model (male or female).

There were 49 research question and hypotheses of this study. For the purposes of brevity, only those of central interest are listed below, although one-way, two-way, and three-way effects were explored.

3.2 Research Questions

3.2.1 Outcome Variable 1: Science, Technology, Engineering, and Mathematics Self-Efficacy

RQ1: Is there a significant difference in STEM task self-efficacy following exposure to an attractive or average looking model?

RQ2: Is there a significant difference in STEM self-efficacy following exposure to a model biography with or without a human interest context?

RQ3: Is there a significant difference between STEM self-efficacy following exposure to a model biography with male gendered language or with female gendered language?

3.2.2 Outcome Variable 2: Science, Technology, Engineering, and Mathematics Career Interest

RQ4: Is there a significant difference in STEM career interest following exposure to an attractive or average looking model?

RQ5: Is there a significant difference in STEM career interest following exposure to a model biography with or without a human interest context?

RQ6: Is there a significant difference between STEM career interest following exposure to a model biography with male gendered language or with female gendered language?

3.3 Researcher Stance

As the principal investigator of this study, it is important to address my background and relationship to the research site. I have been a high school English teacher since 2004, and although the study was conducted in the district where I am currently employed, the study did not include the classes I was teaching nor had I previously taught any of the students who were enrolled in the classes participating in the study.

3.4 Research Site

The next section describes the context in which the study was conducted in the spring semester of 2018. The community, school, and classes are described.

3.4.1 Community

The school community in which the study took place was located in the metropolitan area of a large Midwestern city. It included two large comprehensive high schools in a single district. The surrounding community was working class, having recently welcomed several immigrant populations. Some businesses in the community were Spanish and Polish speaking and the community took great pride in its diversity. Across the two high schools in the district, thirty-one languages were spoken in the homes of the students. Several large industrial parks, factories, and a major international airport made up the foundation of the community's economy.

3.4.2 Schools

The study was conducted in the spring semester in the two high schools that made up the single district. Both schools shared a common curriculum as well as common athletic programs. The schools served ninth through 12th grade from four small communities.

The school district's demographics were fairly diverse, with 29.2 % Hispanic students and 65.0% White. Of the 3,375 students in the district, 48.6% participated in the free and reduced lunch program. The most recent standardized assessment data illustrated that the high school performance on the 2016 ACT was slightly below the state average, with a district composite of 19.2 and that of the state being 20.6.

3.4.3 Classes

Tenth and 11th grade English courses were selected as the settings for the intervention because the courses are graduation requirements and would consequently yield the greatest access to students. These two levels were also chosen because these were courses visited by the district's guidance counselors to begin the discussion on college and career choice. As such, an intervention pertaining to the subject of STEM careers would not be so incongruous as to seem out of place in the classroom.

3.5 Research Design

This study used an experimental, quantitative research design. Experimental research involves control and manipulation of the variables included in the study (Bordens & Abbott, 2002). Experimental research is the best research design for ensuring internal validity and demonstrating causal relationships (Bordens & Abbott, 2002). In this study, the experimental design was appropriate because the variables could be manipulated, with the exception of the gender of the subjects. Subjects came as they were, with their biological genders unable to be manipulated and, as such, efforts were made to maintain a close to 50/50 split of male and female subjects in the sample to reflect the school's gender distribution. Experimental design was also appropriate, as the purpose of the study was to demonstrate a causal relationship between the model biography and STEM self-efficacy or STEM career interest.

Quantitative research is appropriate when variables can be quantified and the nature and significance of relationships between variables can be expressed numerically (Creswell, 2013). This study continuously measured the outcome variables of STEM self-efficacy and STEM career interest using a STEM self-efficacy measurement tool. A qualitative approach was not appropriate because qualitative research focuses on establishing a theory, a model, or a definition (Creswell 2013).

The research questions were addressed using a full-factorial approach and ANOVA analysis techniques. A factorial experiment is an experiment consisting of two or more factors which have discrete values or levels (Ryan & Morgan, 2007). In this study, the factors are model attractiveness, gender of the model, human interest context, and gendered language, each being measured on two discrete levels. A full factorial approach involves all possible combinations of these levels across all factors (Ryan & Morgan, 2007). This is a 2x2x2x2 full factorial design, which involved the subjects being split into 16 (2^4) groups representing all combinations of model attractiveness, model gender, biography context, and gendered language. The data was analyzed separately for male student subjects and female student subject. The advantage of a full factorial design was that the individual effects of each factor, or variable, of the experiment could be quantified, as well as the effects of interactions between the variables (Ryan & Morgan, 2007). This is important for this study as it aimed to determine not only if attractiveness of the model improved STEM self-efficacy or STEM career interest, but also if this impact was significantly different for the sexes, particularly for girls, while simultaneously exploring the effects of other variables. All interactions were explored, up to and including three-way interactions. Statistical analysis took place using a four-way ANOVA, as both outcome variables are continuous, and all other variables are categorical.

Outcome variables of STEM self-efficacy and STEM career interest were measured after each student subject was exposed to a curated biography of a fictionalized scientist describing a fictionalized laboratory position, serving as the stimulus model. This was a one-shot, single intervention design. Single intervention was appropriate to minimize pretest manipulation bias (Fraenkel, Wallen, & Hyun, 1993). The pretest manipulation bias is a type of bias that occurs when pretesting a subject in an experiment heightens the participant's sensitivity, making them systematically alter their behavior during the experiment (Fraenkel et al., 1993). If, prior to the model exposure, attention was called to the fact that the study was exploring STEM self-efficacy, STEM career interest, or anything related to STEM in general, it is likely that participants may have been more aware of STEM themes or systematically changed their reactions to the model biography and the follow-up survey instruments. Attempts were made to avoid this bias. As a result, there was no pretest conducted and students were asked to assess self-efficacy and interest immediately after viewing the fictionalized biography. Therefore, the effects in a change in STEM self-efficacy or STEM career interest were not examined prior to and after exposure to the model bio; the effect on STEM self-efficacy or STEM career interest was only explored after exposure to the model bio. Because interventions may be effective in various forms and lengths, and extensive and repetitive interventions do not necessarily yield stronger results (A. H. Chen et al., 1997), the single intervention was considered appropriate for this study.

3.6 Research Procedures

The following section discusses the study procedures with the previously described participants. Procedures discussed include sampling, recruitment, data collection, treatment, and instrument utilized.

3.6.1 Sampling Procedure

Participants in the study were students enrolled in either their 10th or 11th grade English course. Although research has suggested that female interest and confidence in math and science dips during middle school, there was concern that using middle school subjects would not yield usable data, as there may still have been a substantial portion of girls who had not lost interest in STEM. As such, the sample may be too malleable and vulnerable to manipulation that could be accounted for by factors other than the intervention. By high school, female disinterest in STEM is well documented (N. Anderson, Lankshear, Timms, & Courtney, 2008), and the impact of models may be more evidently obvious. Students in 10th and 11th grade are approximately 16 and 17 years old. As the district has a 47.6% to 52.3% female-to-male ratio, attempts were made to ensure that the sample reflected that gender ratio. Students of both genders and all races and ethnic groups at this public high school were included.

A power analysis was conducted using G* Power 3.1 to calculate the sample size required by this analysis (Faul, Erdfelder, Buchner, & Lang, 2013). The numerator degrees of freedom for a 2x2x2x2 ANOVA is only 1, and assuming an effect of .2, an alpha level of .05, and a desired power of 80, the required sample size is 327. For the purposes of this study, the decision was made to increase the sample size to 600, applying the best practice of having 30 subjects per cell as well as accounting for those who may choose not to participate or abandon the survey mid-intervention. This more conservative approach allowed for the sampling distribution of the means to incline toward normality, one of the assumptions of ANOVA. This resulted in each of the 16 possible combinations of biography (the subject gender cannot be manipulated in this analysis) being completed 37 times, meaning that each of the possible 16 combinations would appear 37 times.

The average 2016 class size in the high school district was 19.6. To meet this sample size, the study required approximately 30 classes of students. All research was completed in a single district, as the school provided consent for students to participate in the study. The final sample size was 580 high school students, which allowed for some subjects to fail to complete the study, while still obtaining a suitably large sample for statistical analysis. Because the district chosen was 1:1, meaning that every student had a personal internet-connected device, in this instance a Chromebook, there was no difficulty gaining computer access during the regular school hours. This was important because the intervention occurred in an online format.

3.6.2 Procedure for Recruitment

The study began with the retention of IRB approval and appropriate approval for use of the STEM survey instruments. Following this, the district was contacted via the administrative offices, the context of the study explained, and permission to conduct research was requested. Because the school district sends home a global consent form, notifying parents that their children will be included in a variety of experiments and educational interventions, no additional consent specific to the study was obtained.

The recruitment, as well as the study, took place in the spring of 2018. The recruitment and the study were conducted in 10th and 11th grade English courses. English courses were specifically chosen because all students take these courses and because this is the academic space in which college and careers counseling occurs. Several times over the course of the school year, college counselors came into the English courses to discuss students' post-secondary academic prospects as well as their possible career interests. As such, the students had a heightened cognizance of their prospective education and career trajectories. Consequently, exploring their STEM self-efficacy and future STEM career interest in this space was a more fluid and congruent exercise, as it was already part of the established curriculum.

3.6.3 Procedure for Data Collection

Participation in the study was conducted entirely online using website gksurvey.com via Yii2 platform. Although all information collected was anonymous, the data were still encrypted to prevent a security breach. The researcher provided the teacher of participating classrooms with a link to the survey ahead of the intervention. To avoid attracting undue attention to students who did not choose to participate, an online exercise was provided as an alternative activity. This was a career interest survey available on the district's counseling website. In this way, if students chose to discuss their respective activities after the fact, both study participants and nonparticipants will have engaged in a similar, career-related activity.

Once the students logged in, they were asked consent to participate in the study. They were greeted with a short introduction that described the activity and the steps that were taken to protect their identity and maintain anonymity. They were asked to check a box indicating their assent to be in the study. Students who refused were thanked for their time and exited from the survey. In order for their responses to register, students had to complete all of the components of the self-efficacy and interest survey. They were informed that if they exited mid-survey, their responses would be deleted and their data would not be recorded. Consequently, had they changed their mind regarding participation at any point, they needed to exit the survey and they would be removed from the analysis.

3.6.4 Treatment

Once the students confirmed their willingness to participate, they were randomly assigned one of the 16 possible fictionalized model biographies. Each student read the model biography in her own time and then continued to a manipulation check to determine the degree to which she paid attention to the model bio. The intention of the manipulation check was to assess the validity of the test results. The manipulation check asked three multiple-choice questions: (a) What is the gender of the scientist whose profile you viewed? (b) What is the job of the scientist whose profile you viewed? (c) At what university is the scientist employed? The manipulation check was intended to serve as a guide for student self-assessment for profile comprehension. If they did not know the answer, they were able to return to the model biography and thus attend to a detail they may have missed. The intended purpose of this was to guide students back to the model bios in the event they skimmed or skipped any of the details and provide them with another opportunity to consider the scientist profiles. Once the manipulation check was completed, the students were asked whether the scientist whose profile they viewed was attractive. This question was accompanied by the photo of their respective scientist model to enhance recall. The question had a binary (1) yes or (2) no answer option. Determining whether the student perceived the model as attractive was integral to the structure of the study as a whole. Models were selected based on the recommendations of the literature on pulchritude (Fink, Grammer, & Thornhill, 2001; B. C. Jones, Little, Burt, & Perrett, 2004; Rhodes, 2006;

Sugiyama, 2005). Although there was some initial concern that beauty may be a cultural construct and standards of beauty may vary by demographic, research suggests that not only do people of differing genders agree on standards of attractiveness (Andreoni, 2008; Dion, 2002; Langlois et al., 2000; Langlois & Roggman, 1990; Langlois, Roggman, & Musselman, 1994), but people of different cultures and races do as well (Cunningham et al., 1995; Langlois et al., 2000; Perrett, May, & Yoshikawa, 1994; Rhodes et al., 2001). That said, it was still felt that assessment of attractiveness is a deeply personal decision and may vary among teenagers. As such, in order to assess if model attractiveness is a salient variable, it was important to determine if the subject found the model attractive in the first place. This was determined through a single multiple-choice question asking the respondent whether the model they viewed was attractive. Once participants completed the manipulation check and the rating of model attractiveness, they moved on to the completion of the survey instrument.

The survey was not timed, and once students completed the self-efficacy and interest scale, they proceeded to the student demographic portion. Student demographics included (a) gender, (b) grade level, (c) ethnicity, (d) birth order in relation to siblings, (e) parents' professional connection to STEM field, (f) past and projected performance in math classes, (g) past and projected performance in science classes, and (h) interest in applying to a post-secondary school upon completion of high school (Appendix C). While it is standard practice to collect some of this demographic information, such as gender and age, other items were chosen explicitly for this study. For example, questions pertaining to parent profession may be illustrative of interest in STEM, whereas birth order might be suggestive of certain motivational behaviors (Black, Grönqvist, & Öckert, 2018).

After completion of the survey instruments, students were thanked for their time. All the data were then downloaded from the website in Microsoft Excel (2007) format for the purposes of statistical analysis.

3.7 Instrumentation

The researcher used a single instrument made up of two components: a STEM self-efficacy test and a STEM career interest test.

3.7.1 Science, Technology, Engineering, and Mathematics Self-Efficacy

STEM self-efficacy was measured using the STEM Career Self-Efficacy Test (SCS-ET) developed by Milner et al. (2014) for use with college-age students. The SCS-ET consists of eight career-related activity items rated on a 5-point Likert-type scale reflecting self-efficacy for engaging in each task. Likert anchors for the test were *not confident, slightly confident, confident, very confident, and extremely confident* (Milner et al., 2014). The eight items on the scale were as follows: (a) design a diagnostic routine for a power plant, (b) modify an equipment design to reduce sound levels, (c) measure the speed of electrons, (d) improve the efficiency of an assembly process, (e) test a new cooling system, (f) improve computer network efficiency, (g) calculate the probability of winning a contest, and (h) design a technology system for distance learning. The factor loadings of these scales ranged from .69 to .81. A total STEM self-efficacy score was calculated by assigning a numeric value to each Likert anchor from 1 through 5.

The SCS-ET was tested on 403 college students from a Southwestern United States University across a variety of races/ethnicities. The instrument has high Cronbach's alpha of 0.97 and was significantly correlated with other measures of STEM self-efficacy and STEM occupational interest used in the study, indicating the instrument is a reliable and valid measure of STEM self-efficacy (Milner et al., 2014). According to Milner et al., the SCS-ET is short and easily deployed, and the high reliability and validity scores indicate that it is appropriate for measuring self-efficacy in STEM for various contexts.

3.7.2 <u>Science, Technology, Engineering, and Mathematics Career Interest</u>

STEM career interest was measured by another instrument developed by Milner et al. (2014), the STEM Career Interest Test (SCIT). Similar to the SCS-ET, the SCIT uses eight items rated on a 5-point Likert-type scale: strongly dislike, dislike, neutral, like, and strongly like (Milner et al., 2014). Items of career interest were comprised of the following descriptions: (a) redesign an engine to improve fuel efficiency, (b) measure the speed of electrons, (c) maintain the main generator in a power plan, (d) analyze problems in aircraft designs, (e) study the nature of quantum physics, (f) study the laws of gravity, (g) apply mathematical techniques to practical problems, and (h) create a computer database. The factor loadings of the items ranged from .64 to .78.

Similar to the SCS-ET, the SCIT has been validated on 403 college students from a Southwestern United States University across a variety of races and ethnicities. The instrument has high Cronbach's alpha of 0.96 and was significantly correlated with other measures of STEM self-efficacy and STEM occupational interest used in the study, indicating that the instrument is a reliable and valid measure of STEM career interest (Milner et al., 2014). According to Milner et al., the SCS-IT is short and easily deployed, and the high reliability and validity scores indicate that it is appropriate for measuring self-efficacy in STEM for various contexts.

3.8 Operationalization of Constructs

3.8.1 Dependent Variable 1

STEM self-efficacy was a dependent variable of this analysis. This variable was measured using a continuous scale using the SCS-ET (Milner et al., 2014). This variable was expected to be normally distributed.

3.8.2 Dependent Variable 2

STEM career interest was a dependent variable of this analysis. This variable was measured using a continuous scale using the SCIT (Milner et al., 2014). This variable was expected to be normally distributed.

3.8.3 Independent Variable 1

Subject gender was the first independent variable of this study and was measured on two levels, coded male (0) and female (1). The variable was not manipulated, and both male and female participants were recruited equally via convenience sampling methods.

3.8.4 Independent Variable 2

Model attractiveness was the second independent variable of this study and was measured on two levels, coded average looking (0) and attractive (1). This variable was manipulated using the choice of model biography photograph and was randomly assigned to study subjects.

3.8.5 Independent Variable 3

Model gender was the third independent variable of this study and was measured on two levels, coded male (0) and female (1). This variable was manipulated using the choice of model biography photograph.

3.8.6 <u>Independent Variable 4</u>

Gendered language was the fourth independent variable of this study and was measured on two levels, coded masculine (0) and feminine (1). This variable was manipulated with choice of gendered language in the model biography pertaining to the job description.

3.8.7 <u>Independent Variable 5</u>

Human interest context was the final independent variable of this study and was measured on two levels, coded context/no context (0) and human interest context (1). The variable was manipulated with the inclusion of a paragraph in the biography explaining the context of the task and job role in a way that either provokes or does not provoke human interest.

3.9 <u>Data Analysis</u>

All analyses took place using IBM SPSS. The data were downloaded from the server in Microsoft Excel form and then uploaded to SPSS. Although the data were checked for accuracy, students with seemingly impossible responses were not removed. It was decided that the sample size was large enough to support improbabilities and outliers. Missing data were adjusted using the “exclude missing cases” option. STEM self-efficacy score and STEM career interest score were calculated and used for analyses.

Factor Analysis (FA) and Principle Components Analysis (PCA) were used to evaluate the items in the STEM self-efficacy and STEM career interest instruments to determine whether they each reflected a single construct. Parametric test assumptions of normality and variance homogeneity were tested using the Shapiro Wilks Test of Normality and Levene’s test for homogeneity of variances. As mentioned earlier, Tukey’s post hoc test was employed to explore further any significant results from ANOVA with more than 2 degrees of freedom.

3.10 <u>Threats to Validity</u>

Validity has two elements: internal and external. Internal validity is the ability of an experiment to correctly identify causal relationships. In this study, a full factorial design was used to explore the causal relationships between STEM self-efficacy and interest and the treatment levels. All treatments were well defined and had clear treatment and control levels. Model bios were assigned to subjects using a random number generator and the researcher had no direct contact with the subjects. There were, however, a few sources of bias in this analysis.

The first source of bias was due to the gender ratios that exist in the student population. Students were recruited from existing classes. The female to male participant ratio was 52.9 % to 46.4%, respectively, whereas the profiles were 50/50 female/male split.

There could also have been systematic biases if students dropped out of the study. This may be due to either lack of interest in STEM or in school in general. If these students did not complete the survey in its entirety, they were systematically removed from the study. There was no record kept of how many people began but failed to complete the survey. Attempts were made to ameliorate this by making the model biography quick to read and including large photographs in an effort to grab attention. It was assumed for data analysis that students paid some attention to the model biography as they had to pass through multiple screens before reaching the survey.

All data were kept in a password-protected computer in a locked office to ensure confidentiality of data. Encryption of collected data strengthened the validity of the study. Internal validity is considered statistical conclusion validity. Threats to statistical validity have three components: reliability of the instrument, data assumptions, and sample size. Reliability of the instrument refers to each instrument used in the analysis producing reliable and valid measures of the variable it is designed to measure. The instruments used in this analysis have had their reliability and validity confirmed by the author of the instruments. However, the instruments were tested on college students, whereas this study was conducted using a high school student sample. As such, the validity of the results may have been compromised.

Data assumptions refers to assumptions related to the data. ANOVA has several assumptions all documented in the previous section, and appropriate assumption checking occurred to ensure that the data do not violate the assumptions of ANOVA analysis.

Finally, there can be statistical validity concerns if the sample size is not large enough. The sample size for this study has been calculated using power analysis in previous sections, and to the total sample size of 580 ensured there was still appropriate statistical validity if some subjects refused to or did not complete the study.

External validity refers to the extent to which the study findings can be generalized to a larger population in different settings. This study was restricted to students who were enrolled in either 10th or 11th grade English classes in one geographic area of the United States. As such, findings from this analysis may only be applicable to students from similar cultural and societal backgrounds as students from the geographic area used in this analysis.

3.11 Ethical Procedures

There are a few ethical concerns in this analysis. First, no explicit parental permission had to be obtained. At the start of each school year, the district informs the parents that their son or daughter will likely be involved in some kind of educational research or intervention. If parents do not want their minor children to participate, they need to notify the school and opt out. As a result, no parents were informed about this study explicitly. It is plausible that some may not have consented to have their children participate, but as they did not opt out of the district research policy, their child was automatically included.

In addition, although the researcher had no direct contact with any of the student participants, the researcher is a teacher in the district. This was mitigated by the fact that none of the students knew who was conducting the study.

No identifying information was collected during any phase of the study. All of the data were encrypted and stored on a password-protected computer and will continue to be so during the duration of time required by the IRB. Once the study has been completed, the data will be destroyed.

3.12 Summary

The purpose of the study was to explore whether gender, attractiveness, and other aspects of a STEM model's biography design impacted the STEM self-efficacy and STEM career interest of high school students. The key finding of this study was to determine whether self-efficacy and career interest could be manipulated by controlling exposure to the attractiveness of a STEM model a female student sees. A 2x2x2x2 full factorial design was used to examine the effects of student gender, model attractiveness, model gender, gendered language, and human interest context on STEM task self-efficacy as measured using a previously published and validated survey tool. The research questions were addressed using an ANOVA exploring all interactions up to three-way interactions. Summary statistics of collected data and results of statistical analyses are presented in Chapter 4.

4. DATA ANALYSIS

The previous chapter outlined the methodological rationale and the steps of the research design. This chapter provides an analysis of the results of the data collected. The data analyses are organized to parallel the research questions. The first part of this chapter examines the instrument, whereas the remainder of the chapter focuses on the impact various model profile components had on student STEM self-efficacy and interest.

4.1 Participants

Five hundred and eighty (580) students participated in the study and completed the survey, which was composed of the STEM Career Self-Efficacy Test (SCS-ET) and STEM Career Interest Test (SCIT) and a subsequent demographic portion. Per the recruitment materials and the Consent forms, only the information of those students who completed the entire survey was recorded. Seven students failed to provide their gender, and 11 left the demographic portion unanswered. Table I illustrates the demographic information of the student participants.

TABLE I

DEMOGRAPHIC INFORMATION FOR SUBJECTS

Demographic Variables	Categories	Number	Percent
Subject gender	Boys	266	46.4
	Girls	307	52.9
Subject race	Am Indian or Alaskan	8	1.4
	Hawaiian or Pacific Islander	5	0.9
	Asian or Asian American	22	3.9
	Hispanic or Latino	344	60.5
	White or Caucasian	190	32.8
	Missing	11	1.9
College Prospects	2 year w/o transfer to 4 year	41	--
	2 year with transfer to 4 year	234	--
	4 year	354	--
Grade level	10^{th}	295	50.9
	11^{th}	274	47.2
	Missing	11	1.9
Subject Birth Order	Oldest	215	37.1
	Middle	137	23.6
	Youngest	181	31.2
	Only	36	6.2
	Missing	11	1.9
Parent in STEM	None	224	38.6
	1 parent	221	38.1
	2 parents	124	21.4
	Missing	11	1.9

4.2 <u>Examination of Instrument</u>

A principal component analysis (PCA) was conducted on the 28 item SCS-ET and STEM Career Interest Test (SCIT) using SPSS version 24. Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Olkin value was .960, exceeding the recommended value of .6 (Kaiser, 1970, 1974), and Bartlett's (1954) Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

PCA revealed the presence of four components with eigenvalues exceeding 1, explaining 54.6%, 7.45%, 5.72%, and 3.83% of the variance, respectively. An inspection of the scree plot revealed a clear break after the first component. Using Catell's (1966) scree test, I decided to retain only one component for further investigation. The Component Matrix, which illustrates the unrotated loadings of each of the items, shows that all of the items loaded quite strongly (above a .6) on the first factor. This reinforces that interpretation that a single factor solution is the most appropriate.

The interpretation of the single component solution is consistent with previous research on the scales. The results of this analysis support the use of the scale as was intended by the scale authors as "a good fit model for the one-factor model across . . . all tests" (Milner et al., 2014, p. 20). A reliability analysis was carried out on the scale. Cronbach's alpha showed the questionnaire to reach a relatively high internal consistency and thus acceptable reliability (α = 0.969).

4.3 Interpretation of Beauty

The study was predicated on the assumption that the student participants would have a similar interpretation of profile attractiveness as did the researchers. Because interpretation of attractiveness is integral, students were asked whether they found the scientist in their profile attractive. The response option set was binary, with "yes" and "no" as the only alternatives.

TABLE II

STUDENT RESPONSES ABOUT BEAUTY

All students		Attractive	Average looking	Total
Student Response	Attractive	217	78	295
	Average looking	85	192	277
	Total	302	270	572

TABLE III

STUDENT RESPONSES BASED ON GENDER

		Correct outcome		
		Accurate	Inaccurate	Total
Student Response	Girls	236	70	306
	Boys	173	93	266
	Total	409	163	572

In general, students rated the profiles as designed (Table II, 1 *df*, $\chi 2_1$, = 103.65, $p <$ .0001). Female students had a significantly higher degree of accuracy identifying attractive individuals than did male students (Table III, $\chi 2_1$= 9.62, p = .0019). Additionally, the gender of the profile did not appear to affect student ability to identify attractiveness (Table IV).

TABLE IV

GENDER OF PROFILE INFLUENCE ON ABILITY TO IDENTIFY ATTRACTIVENESS

Subject	Profile	Accuracy
Male student	Male profile	64%
	Female profile	66%
Female student	Male profile	76%
	Female profile	79%

4.3.1 Conformance to Normality

The data conformed to the normality assumption for ANOVA. Although an examination of the distribution of scores illustrates a concentration of scores below the mean, with the average scale score of 2.56, the Skewness (within ± 1) and Kurtosis (within ± 1) values for the distributions of the STEM SCS-ET and SCIT support conformance to normal distribution.

4.3.2 Examination of Independent Variables

Each of the possible 16 profiles varied in one of the following ways: profile sex (PSex), profile attractiveness (PAtt), inclusion of human interest element (PHum), and use of gendered language (PLang). As a result, the profiles were not treated as 16 individual variables (one for each possible profile combination) but instead as four independent variables: profile sex (PSex), profile attractiveness (PAtt), inclusion of human interest element (PHum), and use of gendered language (PLang). Each variable is dichotomous and allows for the exploration of individual and joint effects of four independent variables on one dependent variable, the average student survey response.

A one-way analysis of variance is used to determine whether there are any statistically significant differences between the means of *independent* groups (Field, 2009) and thus ignores the possibility that the variables making up the profiles may be correlated. Treating the profiles as one independent variable omitted the possible effects of all the other variables. A factorial approach is appropriate when levels of each treatment variable are found in combination with levels of the other treatment variables. The main advantage of this is the ability to explore each treatment variable individually and then in combination, permitting the identification of significant interaction between treatment variables. Consequently, a factorial ANOVA was used as it can test both the main effect for each independent variable as well as explore the possibility of an interaction effect (Pallant, 2016).

4.4 Addressing the Research Question

The central question at hand is as follows:

To what degree does the manipulation of a message pertaining to STEM impact STEM interest and self-efficacy of the message recipient?

For the examination of the question, four variables were manipulated:

1. Gender of the STEM model: male or female
2. Attractiveness of the STEM model: attractive or average looking
3. Gendered language: male or female
4. Human interest element: included or excluded

4.4.1 Statistical Procedure

In order to the address the question of message impact, a four-way analysis of variance was conducted on the mean SCS-ET and SCIT scores. The profiles were treated as four independent variable components in accordance to the four types of profile variations: Profile Sex, Profile Attractiveness, Profile Human Element, and Profile Language. The four-way ANOVA revealed a significant three-way interaction between gendered language, model attractiveness, and model gender, $F(1, 561) = 6.50$, $p = .01$, $\eta^2 = .052$ (Pallant, 2016; see Table V).

TABLE V

ANOVA

Source	*df*	SS	MS	*F*	*p*
Corrected model	15	23.669945	1.58	1.91	.019
Intercept	1	3770.705	3770.705	4586.02	.000
PSex	1	. 0.362846	.363	.44	.507
PAtt	1	3.500963	3.50	4.26	.040
PLang	1	5.139887	5.14	6.25	.013
PHum	1	0.242531	.24	.29	.587
PSex*PAtt	1	0.140518	.14	.17	.679
Psex*PLang	1	4.126116	4.13	5.01	.025
PSex*PHum	1	0.000017	1.71	.000	.996
PAtt*Plang	1	0.074263	.075	.09	.764
PAtt*PHum	1	0.367502	.37	.4447	.504
PLang*PHum	1	0.212788	.21	.259	.611
PSex*PAtt*PLang	1	5.345351	5.35	6.50	.011
PSex*PAtt*PHum	1	0.728681	.72	.89	.347
PSex*PLang*PHum	1	0.128243	.12	.16	.693
PAtt*PLang*PHum	1	0.000113	.00	.00	.991
PAtt*PSex*PLang*PHum	1	2.667158	2.67	3.24	.072
Error	561	461.26	.822		
Total	577	4269.95			
Corrected Error	576	484.93			

There were also significant two-way interactions between Profile Sex and Profile Language, $F(1, 561) = 5.01$, $p < .05$, and significant main effects for Profile Attractiveness, $F(1, 561) = 4.26$, $p < .05$, and Profile Language, $F(1, 561) = 6.25$, $p < .05$. The difference in the means is illustrated in Figure 8.

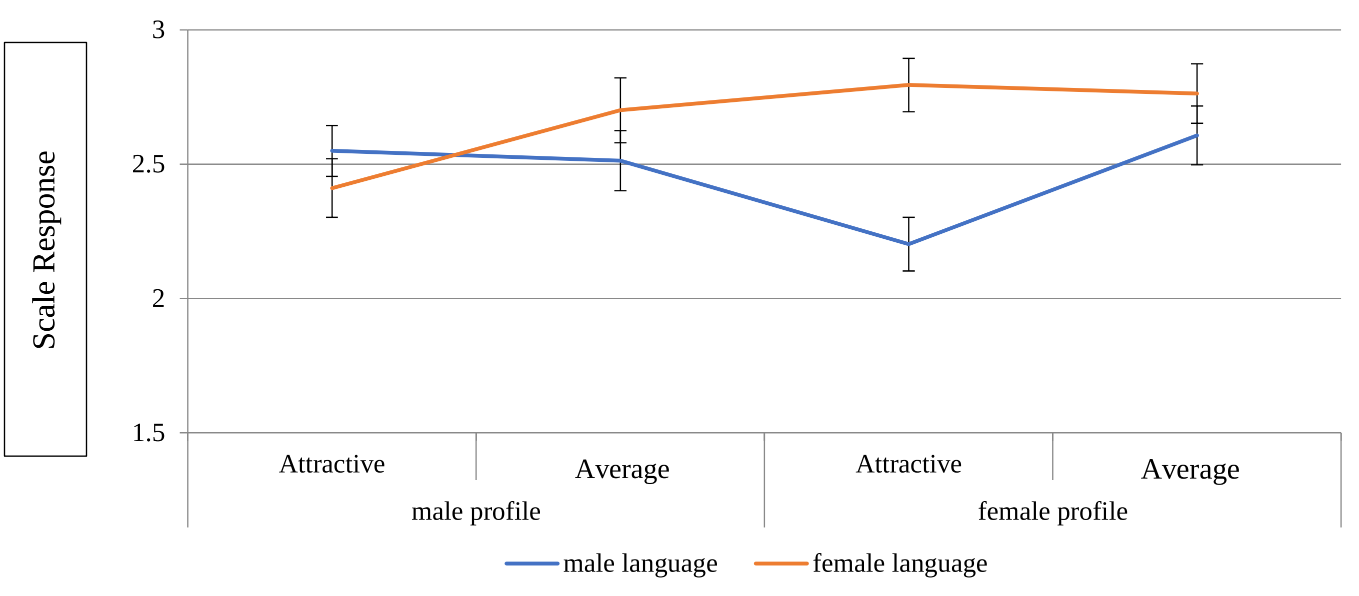

Figure 8. Graph of attractive versus average looking for male and female profiles.

While there is little dissimilarity in scores among those who viewed an average looking profile, those students for whom an attractive profile was generated had more variation in their results. Tables VI through VIIII illustrate that individuals who read the profile of an attractive, female scientist with female language had the highest score averages (*M* = 2.79, *SD* = .831), while those who viewed an attractive, female scientist with male language had the lowest (*M* = 2.20, *SD* = .861). It is interesting to note that for average looking scientists, profiles using female language generated the highest means, regardless of profile gender, while attractive scientist profiles yielded higher scores only when the sex of the scientist matched the gender of the language.

TABLE VI

PROFILE ATTRACTIVENESS

Profile Attractiveness	*M*	*SD*	*n*
Attractive	2.48	.895	303
Average	2.64	.936	274

TABLE VII

PROFILE SEX

Profile Sex	*M*	*SD*	*n*
Male	2.54	.934	299
Female	2.58	.900	278

TABLE VIII

PROFILE SEX AND LANGUAGE

Profile Sex*Profile Language		*M*	*SD*	*n*
Male	Masculine Language	2.53	.910	160
	Feminine Language	2.55	.964	139
Female	Masculine Language	2.39	.903	143
	Feminine Language	2.78	.858	135

TABLE IX

PROFILES SEX, ATTRACTIVENESS, AND LANGUAGE

Profile Sex*Profile Attractiveness*Profile Language			*M*	*SD*	*n*
Male	Masculine	Attractive	2.55	.878	87
		Average	2.51	.95	73
	Feminine	Attractive	2.41	.923	72
		Average	2.70	.991	67
Female	Masculine	Attractive	2.20	.86	74
		Average	2.61	.907	69
	Feminine	Attractive	2.79	.831	70
		Average	2.76	.892	65

Because the literature supports an expectation that boys and girls would respond to the messages differently, the results were graphed separately for male and female students (Figures 9 and 10).

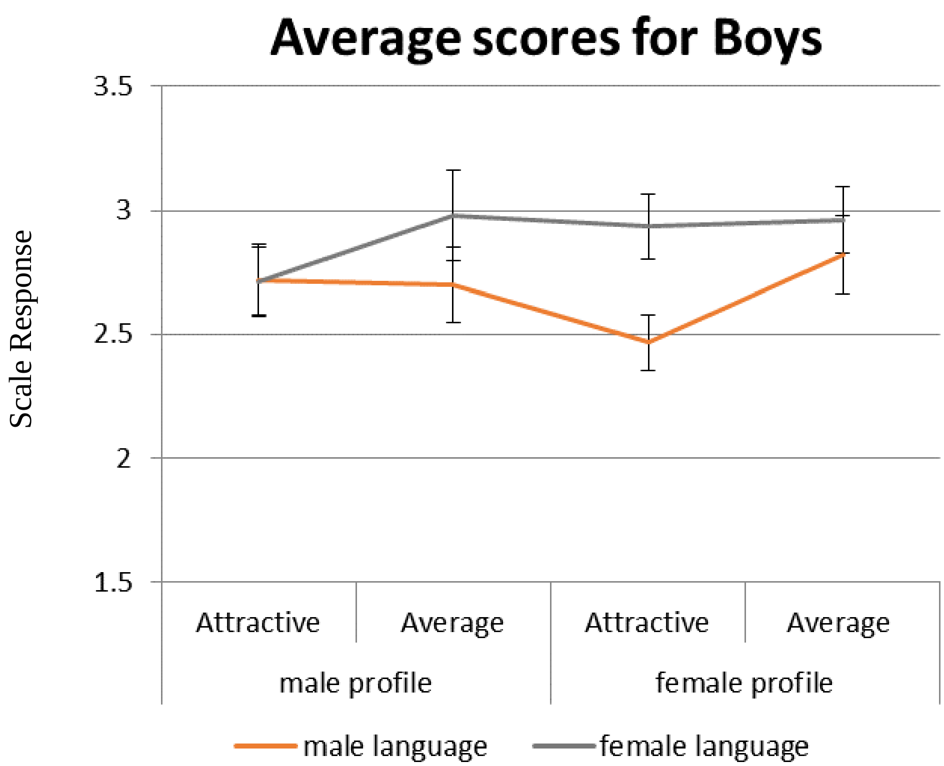

Figure 9. Average scores for boys.

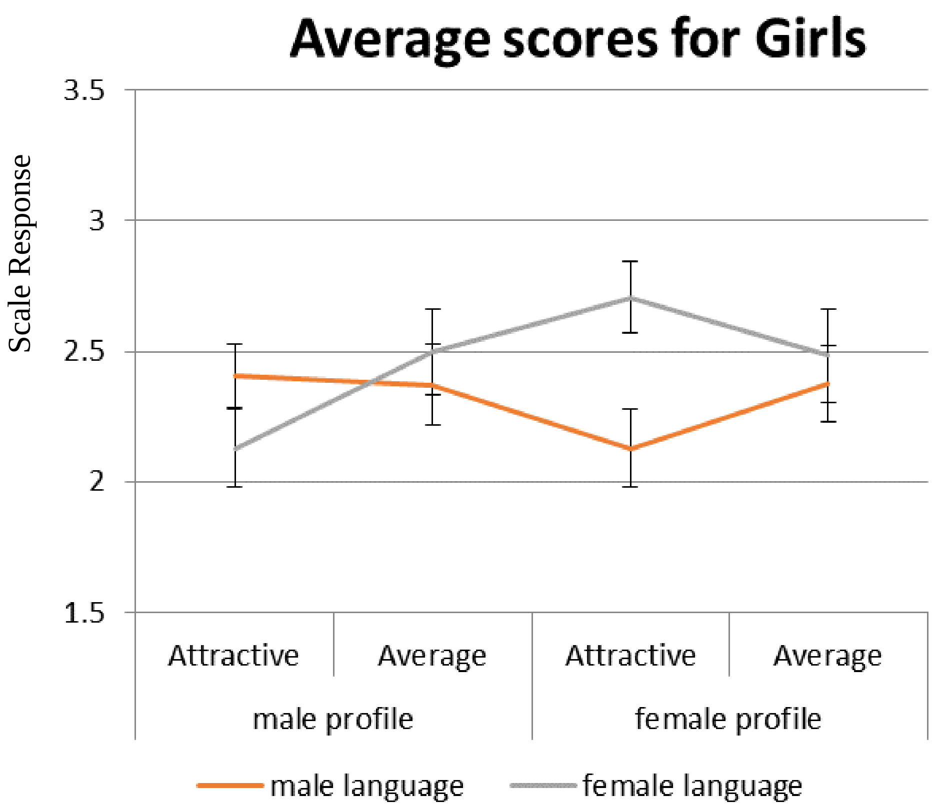

Figure 10. Average scores for girls.

What is illuminated most glaringly is that male students scored better than female students on the STEM self-efficacy and interest scale. Additionally, when male students viewed male scientist profiles, the gender of the language did not matter if the scientist was attractive. However, if the male students viewed an average looking male scientist, female gendered language yielded higher mean self-efficacy and interest scores than male gendered language. When male students viewed female scientist profiles, attractiveness of the profile did not mediate the influence of the gendered language. Regardless of female scientist degree of attractiveness, male students scored higher when female gendered language was used.

Female students who viewed an attractive female profile that used female language had significantly higher score averages than any of the other profile combinations (*M* = 2.701, *SD* = .908). The two lowest mean scores were also yielded from the attractive profiles, with the male profile and female language combination (*M* = 2.129, *SD* = .929) and the female profile and male language combination (*M* = 2.011, *SD* = .967).

Thus, when the profile presents an average looking scientist, language matters not, regardless of the gender of the model. However, when the profile is attractive, congruence between the model sex and the language gender yields the most positive outcome. Similarly, in attractive models, incongruence between the sex of the model and the gender of the language yields the least positive results. Female language yields a constantly more positive result for male students than for female students and produces less variability in scores in either of the two model genders. When using male language, attractive female models produce the least positive results for both male and female students.

4.4.1.1 **Female Subjects**

Because the male students had higher mean scores than female students and because the focus of the research was specifically anchored around female interest and confidence in STEM, the sample was split to examine the profile variations and the genders separately. The four-way ANOVA revealed significant three-way interactions between gendered language, model attractiveness, and model gender, $F(1, 289) = 5.8$, $p < .05$ (see Table X).

TABLE X

ANOVA: FEMALE SUBJECTS

Source	*df*	SS	MS	*F*	*p*
Corrected model	15	17.278735	1.15	1.35	.171
Intercept	1	1651.153613	1651.15	1936.57	.000
PSex	1	0.149608	.15	.18	.676
PAtt	1	0.994198	.994	1.17	.281
PLang	1	1.808988	1.81	2.12	.146
PHum	1	0.443041	.44	.52	.472
PSex*PAtt	1	0.172826	.17	.20	.653
PSex*PLang	1	3.542663	3.5	4.16	.042
PSex*PHum	1	0.177717	.18	.21	.648
PAtt*Plang	1	0.099728	.10	.18	.733
PAtt*PHum	1	0.394849	.40	.46	.497
PLang*PHum	1	0.577679	.58	.68	.411
PSex*PAtt*PLang	1	4.942115	4.94	5.80	.017
PSex*PAtt*PHum	1	0.381349	.38	.45	.504
PSex*PLang*PHum	1	0.050987	.05	.06	.807
PAtt*PLang*PHum	1	0.032234	.03	.04	.846
PAtt*PSex*PLang*PHum	1	1.798222	1.80	2.11	.148
Error	289	246.406921	.85		
Total	305	1975.350765			
Corrected Error	304	263.685656			

There were also significant two-way interactions between Profile Sex and Profile Language, $F(1, 289) = 4.16$, $p < .05$

4.4.1.2 <u>Male Subjects</u>

For the male student participants, only profile language was significant, $F(1,250) = 4.096$; $p = .044$ (Table XI), with profile gender, profile attractiveness, and human element proving nugatory.

TABLE XI

ANOVA: MALE SUBJECTS

Source	*df*	SS	MS	*F*	*p*
Corrected model	15	8.89	.592	.80	.668
Intercept	1	2033.43	2033.43	2774.08	.000
PSex	1	.014	.014	.02	.890
PAtt	1	1.617	1.617	2.21	.139
PLang	1	3.00	3.00	4.01	.044
PHum	1	3.02	3.02	.000	.995
PSex*PAtt	1	.89	.89	.12	.731
PSex*PLang	1	.47	.47	.65	.422
PSex*PHum	1	.02	.02	.03	.856
PAtt*PLang	1	.00	.00	.002	.965
PAtt*PHum	1	.05	.05	.07	.792
PLang*PHum	1	.03	.03	.05	.831
PSex*PAtt*PLang	1	1.62	1.62	2.21	.138
PSex*PAtt*PHum	1	.68	.68	.92	.338
PSex*PLang*PHum	1	.76	.76	1.04	.308
PAtt*PLang*PHum	1	.02	.02	.03	.850
PAtt*PSex*PLang*PHum	1	.53	.53	.72	.397
Error	250	183.253			
Total	266	2257.35			
Corrected Total	256	192.14			

An investigation of the means illustrates that male subjects exposed to a profile with female language (M = 2.9, SD = .83) had higher mean scores than those exposed to profiles with male language (M = 2.69, SD = .86).

4.4.2 <u>Additional Variables as Possible Sources of Influence</u>

Once the central question was addressed, the student demographics were evaluated to see if they helped explain student STEM self-efficacy and interest and contributed to an understanding of student responses to the experimental treatments. The demographics explored included (a) race, (b) birth order, (c) parent occupation, and (d) post-secondary education plans.

4.4.2.1 Race

The race question was the following: Are there racial differences in student self-efficacy and interest in STEM and how do they respond to the treatment message? Students self-identified into five race categories: American Indian or Alaskan, Hawaiian or Pacific Islander, Asian or Asian American, Hispanic or Latino, and White or Caucasian. A one-way ANOVA demonstrated that there were no differences among the races in terms of their mean scores (Table XII) on the STEM Career Self-Efficacy Test (SCS-ET) and STEM Career Interest Test (SCIT): $F(4,564)=2.15$, $p = .073$.

TABLE XII

STEM CAREER SELF-EFFICACY TEST AND STEM CAREER INTEREST TEST

Race	*M*	*n*	*SD*
Am Indian or Alaska	2.78	8	.94
HI or Pacific Is	3.30	5	.36
Asian or Asian Am	2.98	22	.92
Hisp or Latino	2.53	344	2.53
White or Cauc	2.55	190	2.54
Total	2.57	569	.91

The one-way ANOVA was then re-run excluding American Indian or Alaskan and Hawaiian or Pacific Islander on the grounds of small sample size, 8 and 5, respectively. Once again, no significance among the racial groups was found, $F(2, 553) =2.42$, $p = .09$.

Student gender was added to race and analyzed by a two-way between group analysis of variance to determine where there was a relationship between student sex and race on the STEM Career Self-Efficacy Test (SCS-ET) and STEM Career Interest Test (SCIT). Because there were so few students who self-identified as American Indian or Alaskan or Hawaiian or Pacific

Islander, they were excluded from the analysis. The test illustrated that the interaction effect between race and sex was not statistically significant, $F(2, 550) = .66$, $p = .518$ (Table XIII). The data suggest that, as it relates to race, the test scores do not seem to be influenced by the sex of the student respondent. That is, as seen before, boys scored higher than girls, regardless of gender, with Asian or Asian American, Hispanic or Latino, and White or Caucasian students all responding similarly.

TABLE XIII

RELATIONSHIP BETWEEN STUDENT SEX AND RACE

Source	*df*	SS	MS	*F*	*p*
Corrected model	9	33.30	3.70	4.65	.00
Intercept	1	486.75	486.75	611.93	.00
Sex	1	4.22	4.22	5.31	.022
Race	4	4.64	1.20	1.46	.214
Sex*Race	4	2.30	.58	.72	.577
Error	599	444.65	.80		
Total	569	4222.70			
Corrected Total	568	478.00			

Subsequent analyses were conducted to explore the relationship between race and each of the four profile treatments. Once again, restrictions were made based on sample size and only Asian or Asian American, Hispanic or Latino, and White or Caucasian students were included. An analysis of variance indicated no significant difference: The STEM self-efficacy and interest mean scores did not differ significantly among the racial groups. Additionally, the different racial groups responded similarly to the differences in the profile, meaning that no variable (Profile Sex, Profile Attractiveness, Gendered Language, and Human Element) impacted one racial group differently than another.

4.4.2.2 Birth Order

The birth order question was the following: Does birth order influence students' self-efficacy and interest in STEM and/or their response to the treatment message? An ANOVA was conducted to examine the effects of birth order on the STEM Career Self Efficacy Test and STEM Career Interest Test. The results showed that the effect of birth order on the mean scores was significant, $F(3, 565) = 3.05$, $p = .028$ (Table XIV).

TABLE XIV

ANALYSIS OF VARIANCE

Source	*df*	SS	MS	*F*	*p*
Corrected model	3	7.60	2.54	3.045	.028
Intercept	1	2352.20	2352.20	2824.40	.000
Birth Order	3	7.06	2.54	3.05	.028
Error	565	470.34	.83		
Total	569	4222.70			
Corrected Total	568	477.94			

Post-hoc comparisons using Tuckey's HSD indicated that the mean scores for first-born children were significantly lower than the mean scores for youngest children. Neither middle children nor only children differed significantly from the other groups (Table XV).

TABLE XV

POST-HOC COMPARISONS

Birth Order	*M*	*n*	*SD*
Oldest	2.46	215	.90
Middle	2.50	137	.94
Youngest	2.72	181	.91
Only	2.62	36	.92
Total	2.67	569	.92

Despite reaching statistical significance, the actual difference in mean scores between the groups was quite small. The effect size, calculated using eta squared, was .02. This calls into questions the practical applicability and usefulness of the scores difference.

Once the two age groups with significant differences were identified, a two-way between group analysis of variance was conducted to determine the impact of sex and birth order on the STEM Career Self-Efficacy Test (SCS-ET) and STEM Career Interest Test (SCIT). Only children were excluded from further exploration on the basis of a small sample size ($N = 36$). A two-way ANOVA conducted on oldest, middle, and youngest children illustrated that the interaction effect between birth order and sex was not statistically significant, $F(3, 561) = .29$, $p = .833$. The birth order difference in test scores does not appear to be influenced by the sex of the student. That is, last-born children, regardless of gender, show a stronger interest in STEM than oldest or middle children in the family.

Subsequent analyses were conducted to explore the relationship between birth order and each of the four profile treatments. Only children were once again excluded on the basis of a small sample size. Separate four-way ANOVAs were conducted on birth order versus each profile treatment: profile attractiveness, profile sex, profile language, and human component. None of the four profile treatments indicated a statistically significant interaction effect: $F(3,561) = 2.07$, $p = .103$ (profile attractiveness); $F(3,561) = 1.5$, $p = .215$ (profile sex); $F(3,561) = 1.07$, $p = .363$ (profile language); $F(3,561) = 1.65$, $p = .18$ (human component). Thus, while youngest children in this study showed a stronger interest in STEM than oldest children in the family, they all responded similarly to the profile treatments.

4.4.2.3 Parent Involvement

The question about parent involvement in STEM-related occupation was the following: Do children of STEM parents show a stronger interest in STEM and will they respond differently to STEM messaging than children of non-STEM parents? Therefore, the next demographic of interest was whether or not a parent's involvement in a STEM-related career had any bearing on the degree of interest or efficacy in STEM. The demographic portion of the survey included the following four questions that pertained to the vocational occupation of the parents:

1. Consider your father's profession. Would you say that he works in a field that is in any way related to science, technology, engineering, or math? This DOES NOT include the field of medicine

2. Consider your father's profession. Would you say that he works in a field that is in any way related to science, technology, engineering, or math? This includes the field of medicine

3. Consider your mother's profession. Would you say that she works in a field that is in any way related to science, technology, engineering, or math? This DOES NOT include the field of medicine

4. Consider your mother's profession. Would you say that she works in a field that is in any way related to science, technology, engineering, or math? This includes the field of medicine

There was a series of questions that guided the analysis of this demographic. Of particular interest were the following:

1. Did students with varying numbers of STEM parents respond differently in a way that is significant?

2. Did the gender of the STEM parent matter in relation to the gender of the subject?

3. Did the type of STEM (medical or non-medical) matter for the gender of the subject?

4. Did the type of STEM x gender of STEM parent x gender of subject matter?

4.4.3 Research Question 1

Research Question 1 was the following: Did students with varying numbers of STEM parents respond differently in a way that is significant? It was hypothesized that there would be an increase in the mean score if students had one parent in STEM as opposed to no parent in STEM. It also made sense that there may be another marginal increase if there were two parents in STEM as opposed to one. A one-way ANOVA with three levels (no parent in STEM, one parent, and two parents in STEM) did not support this hypothesis, $F(2, 566) = 1.19$, $p = .306$, suggesting that the number of parents in a STEM-related career bore no impact on student interest or efficacy in STEM. Although the difference in the means was not significant, they are in opposition to the prediction: Male students' scores were lower when there were two parents in STEM than with the presence of only one parent in STEM (Table XVI).

TABLE XVI

ANOVA: PARENTS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

Subject Sex		*M*	*N*	*SD*
Male	No parents in STEM	2.75	102	.94
	One parent in STEM	2.88	108	.78
	Two parents in STEM	2.69	55	.78
	Total	2.79	265	.85
Female	No parents in STEM	2.28	122	.94
	One parent in STEM	2.39	113	.86
	Two parents in STEM	2.47	69	1.02
	Total	2.37	304	.93
Total	No parents in STEM	2.50	244	.97
	One parent in STEM	2.63	221	.86
	Two parents in STEM	2.57	124	.92
	Total	2.57	569	.92

4.4.4 Research Question 2

Research Question 2 was the following: Did the gender of the STEM parent matter in relation to the gender of the subject? It was predicted that girls would be influenced by their mother's involvement in STEM rather than by their fathers. In order to address this hypothesis, a dummy variable was created that identified either the father or the mother as having a STEM-related career. The variable was coded in one of two ways: 1. Mom in STEM, but not Dad or 2. Dad in STEM, but not Mom. I selected only those students who had a single parent in STEM to determine whether the gender of the STEM parent makes a difference. In total, there were 55 kids who had a mom in STEM but not a dad, and 209 kids who had a dad in STEM but not a mom (Table N).

TABLE XVII

PARENTS INVOLVED IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

Subject Sex		*M*	*n*	*SD*
Male	Mom in STEM Dad not	3.00	24	.93
	Dad in STEM Mom not	2.90	70	.76
	Total	2.92	94	.80
Female	Mom in STEM Dad not	2.38	2.38	31
	Dad in STEM Mom not	2.42	69	.87
	Total	2.41	100	.86
Total	Mom in STEM Dad not	2.63	55	.93
	Dad in STEM Mom not	2.66	139	.84
	Total	2.66	194	.87

A two-way ANOVA was conducted on the basis of the hypothesis. The results of the analysis did not support the prediction. The gender of the parent made no impact on the way students responded to the survey. Although the difference in the STEM self-efficacy and interest scores did not prove to be significant, it was interesting to note that the raw means were actually in opposition to the predictions. Girls whose fathers were in STEM had a higher response score than those whose mothers were in STEM (Figure 11).

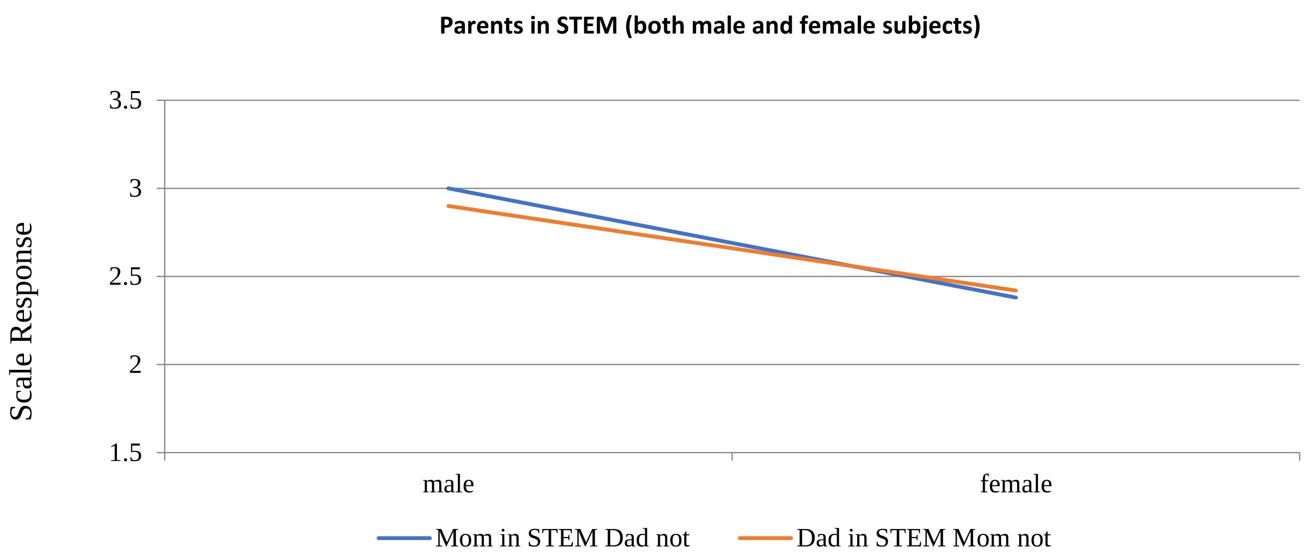

Figure 11. Parents in science, technology, engineering, and mathematics.

When looking at students who only had a mom, and not a dad, in STEM, the four-way ANOVA revealed significant three-way interactions between model attractiveness, gendered language, and presence of a human element, $F(1, 39) = 4.71$, $p < .036$ (see Table XVIII).

TABLE XVIII

ANOVA: MODEL ATTRACTIVENESS, GENDERED LANGUAGE, AND PRESENCE OF A HUMAN ELEMENT

Source	*df*	SS	MS	*F*	*p*
Corrected model	15	9.07	.604	.621	.840
Intercept	1	244.31	244.307	250.84	.000
PSex	1	.035	.035	.036	.851
PAtt	1	1.42	1.42	1.491	.229
PLang	1	.207	.207	.212	.648
PHum	1	.506	.506	.520	.475
PSex*PAtt	1	.125	.125	.129	.722
PSex*PLang	1	.016	.016	.017	.897
PSex*PHum	1	.018	.018	.018	.894
PAtt*PLang	1	.925	.925	.949	.336
PAtt*PHum	1	4.442	4.442	4.560	.039
PLang*PHum	1	.010	.010	.010	.920
PSex*PAtt*PLang	1	.003	.003	.003	.956
PSex*PAtt*PHum	1	.106	.106	.108	.744
PSex*PLang*PHum	1	.065	.065	.067	.797
PAtt*PLang*PHum	1	4.584	4.707	4.707	.036
PAtt*PSex*PLang*PHum	1	6.11	6.11	.000	.994
Error	39	37.984	.974		
Total	55	428.569			
Corrected Total	54	47.049			

An examination of the means (Table XIX) suggests that male language accounted for both the highest (*M* = 3.45, *SD* = 1.03) and the lowest (*M* = 1.36, *SD* = 1.01) scores in the interaction. Although both the highest and the lowest scores occurred with the absence of a human element, the high score occurred with the presence of an attractive model, whereas the low score occurred with the presence of an average looking model.

TABLE XIX

MEANS

		Human element		No Human element		
		M	*SD*	*M*	*SD*	Δ
Attractive	Male language	2.31	.466	3.45	1.03	1.14
	Female language	2.85	.52	2.58	1.22	.026
Average looking	Male language	3.00	1.02	1.36	.10	1.64
	Female language	2.65	.97	2.48	.98	.25

In all instances, the average score increased with the presence of a human element, with the exception of the attractive profile utilizing male language and excluding human element (Figure 12).

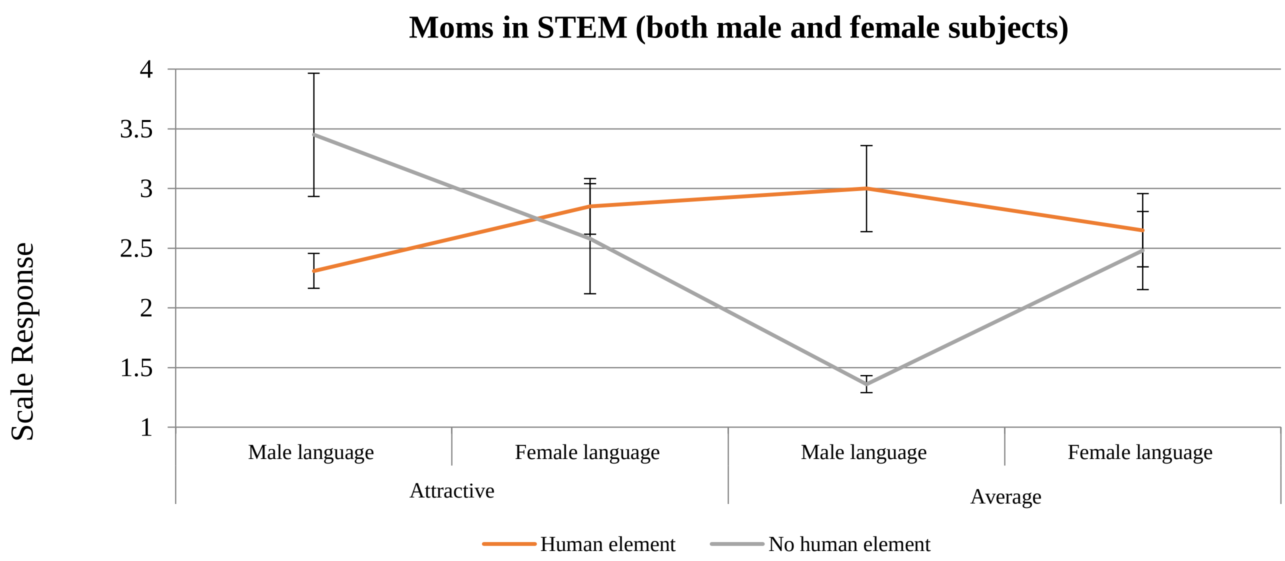

Figure 12. Mothers in science, technology, engineering, and mathematics.

Two different significant two-way interactions occurred for students whose fathers, rather than mothers, were in a STEM field: Profile Sex and Profile Language, $F(1, 123) = 7.65$, $p < .007$, as well as Profile Language and Human Component, $F(1, 123) = 756$, $p < .007$ (Table XX).

TABLE XX

PARENTS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

Source	*df*	SS	MS	*F*	*p*
Corrected model	15	22.08	1.47	2.361	.005
Intercept	1	817.98	817.96	1311.657	.000
PSex	1	.260	.260	.418	.519
PAtt	1	.649	.649	1.040	.310
PLang	1	1.792	1.792	2.874	.093
PHum	1	.265	.265	.424	.516
PSex*PAtt	1	.531	.531	.852	.358
PSex*PLang	1	4.77	4.77	7.650	.007
PSex*PHum	1	9.72	9.72	.000	.990
PAtt*PLang	1	.015	.015	.024	.877
PAtt*PHum	1	1.932	1.932	3.098	.081
PLang*PHum	1	4.716	4.716	7.56	.007
PSex*PAtt*PLang	1	1.098	1.098	1.761	.187
PSex*PAtt*PHum	1	1.226	1.226	1.96	.163
PSex*PLang*PHum	1	.099	.099	.159	.690
PAtt*PLang*PHum	1	.165	.165	.265	.608
PAtt*PSex*PLang*PHum	1	.621	.621	.995	.320
Error	123	76.704	.624		
Total	139	1088.06			
Corrected Total	138	98.790			

The means (Table XXI) illustrate that the congruence between the sex of the model and the gender of the language is important, as the two highest scores occurred in the presence of a male profile and male language ($M = 2.75$, $SD = .996$) and female profile ($M = 3.06$, $SD = .657$). A natural question arose as to how these scores reflected the gender of the student participants, but low sample size made such analyses impossible.

TABLE XXI

MEANS FOR SEX OF THE MODEL AND THE GENDER OF THE LANGUAGE

	Male Language		Female Language		
	M	*SD*	*M*	*SD*	Δ
Male profile	2.75	.996	2.54	.807	.21
Female profile	2.389	.738	3.06	.657	.671

The difference in the mean scores of the female profile is particularly noteworthy, suggesting the salient role of gendered language in female profiles (Figure 13).

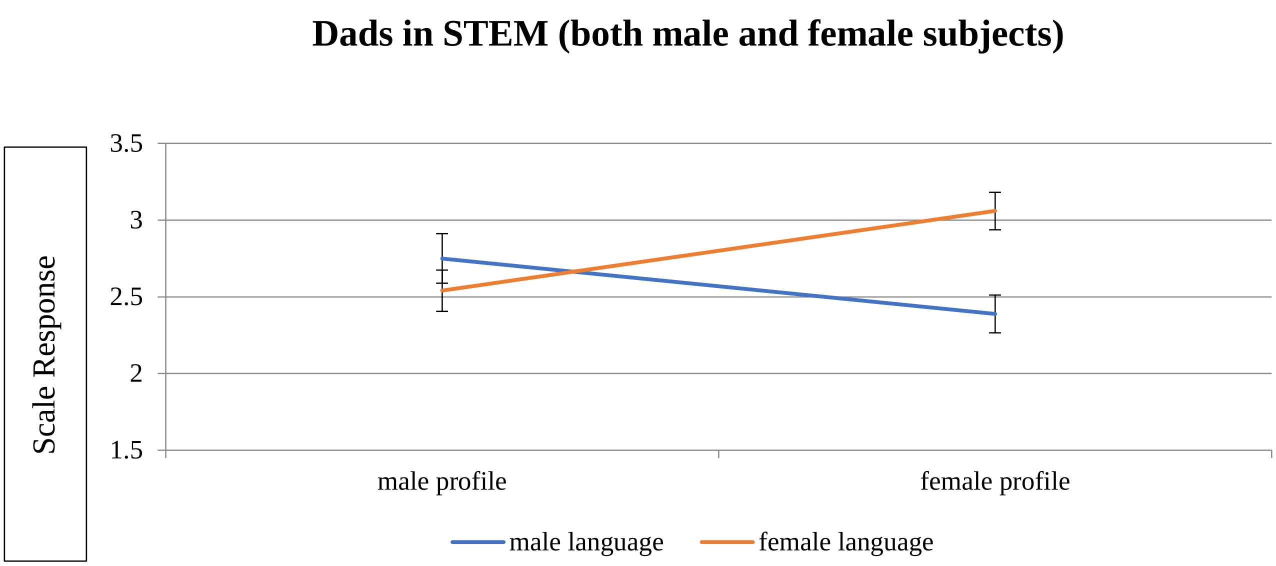

Figure 13. Language in science, technology, engineering, and mathematics.

The interaction between gendered language and human element suggests that the combination of female language and human element predicts the highest degree of efficacy and interest (*M* = 2.92, *SD* = .673) in STEM, whereas male language and human element predicts the lowest (*M* = 2.29, *SD* = .962; Table XXII).

TABLE XXII

LANGUAGE IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

	Male Language		Female Language		
	M	*SD*	*M*	*SD*	Δ
Human element	2.29	.962	2.92	.673	.631
No human element	2.77	.794	2.62	.866	.15

The scores suggest that it is the presence of the human element component, rather than the absence of it, that proves to be most consequential (Figure 13).

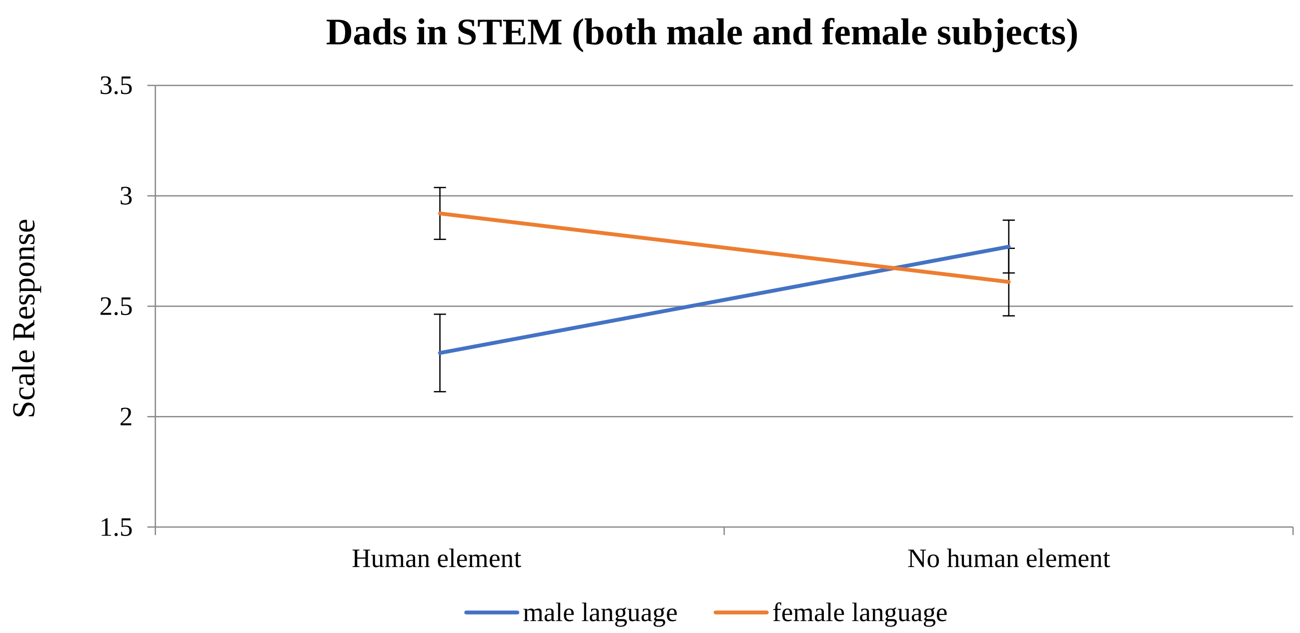

Figure 14. Human element in science, technology, engineering, and mathematics.

4.4.5 Research Questions 3 and 4

Research Questions 3 and 4 asked the following: Did the type of STEM (medical or non-medical) matter for the gender of the subject? Did the type of STEM x gender of STEM parent x gender of subject matter? Although medical careers were intentionally isolated from the general STEM careers in order to reflect the current trends in occupational interest and pursuits, the data suggest that the students did not make distinctions between medical and non-medical STEM. On multiple occasions, students identified either one or both parents as being in both a medical and non-medical STEM field, making analysis on the distinction between the two impossible. In other words, because students confounded medical and non-medical STEM careers, separating the two for the purposes of analysis proved impossible.

4.4.5.1 Post High School Plans

The question for post high school plans was the following: Do student with differing post-secondary plans respond differently to the message treatments? To differentiate student future intention for college, students were coded in one of three ways: a. No plan to attend college b. Plan to attend a two-year institution and either transfer at a later time or not c. Plan to attend a four-year institution. Because in certain instances students marked intentions that seemed incongruous (for example, marking both two year with no intent to transfer as well as four year), the following coding criteria was established: Students who indicated “no college” were marked as “no college” regardless of what they put for other categories; students who indicated “two year and transfer” were labeled as “two year,” regardless of whether or not they also indicated an affirmative for the “four year” category. The re-coding was done to ameliorate ambiguity of the questions. Students who marked no categories were coded as “no college.” A one-way ANOVA conducted on post-secondary interest illustrated that the only significant difference in mean scores occurred between students with no interest in post-secondary pursuits and those intending to attend a four-year institution, $F(2, 566) = 4.07$, $p = .018$ (Table XXIII).

TABLE XXIII

ANOVA ON POST-SECONDARY INTEREST

Source	*df*	SS	MS	*F*	*p*
Corrected model	2	6.77	3.38	4.07	.018
Intercept	1	2681.67	2681.67	3221.37	.000
College Plans	1	6.77	3.39	4.07	.018
Error	566	471.18	.83		
Total	569	4222.70			
Corrected Total	568	477.94			

A post hoc Tukey's test showed that students who are interested in attending a four-year institution have more interest and confidence in STEM than students who have no interest in collegiate pursuits at $p < .05$ (Table XXIV).

TABLE XXIV

POST HOC TUKEY'S TEST

College Plans	*M*	*SD*	*n*
No college or uncertain	2.38	0.90	130
2-year (may or may not transfer)	2.51	0.94	94
4-year	2.65	0.91	345
Total	569	2.57	0.92

4.4.5.2 Number of Math and Science Courses Taken

Germaine to the topic of post high school plans is the examination of the number of math and science courses taken as well as the number of math and science courses the students intended to take. Because the high school graduation requirement is four semesters of math and four semesters of science, anything beyond that may be illustrative of student preparation for college.

The relationship between total core math courses taken and the composite of the SCS-ETSCIT was investigated using the Pearson correlation coefficient. There was a very small negative correlation between the two variables (r =-.091, n = 530, $p < .05$). Similarly, small negative correlations were also observed for the total of core science and honors science courses taken (r = -.035, n = 415 and r =-.118, n = 283, $p < .05$, respectively). The only positive relationship for student career and interest mean scores was with honors math courses (r = .157, n = 490, $p < .01$; Table XXV). That is, students who take more math courses also show a higher interest in science. It should be noted that although the correlation was the strongest of the set, it is still considered a weak relationship.

TABLE XXV

STUDENT SCORES

	Average Student Survey Score	Math Total-Core	Math Total-Honors	Science Total-Core	Science Total-Honors
Average Student Survey Score	1				
Math Total-Core	-.091*	1			
Math Total-Honors	.157**	.118**	1		
Science Total-Core	-.35	.076	.044	1	
Science Total-Honors	-.118*	-.108	-.067	.334**	1

Note. *Correlation is significant at the 0.05 level (2-tail); **Correlation is significant at the 0.01 level (2-tail).

The negative relationships, however, were not universal, as was revealed once gender was considered. Illustrated below (Tables XXVI and XXVII) are the differences between the two: While the correlation between courses taken and overall mean scores was negligible for the girls, the boys appeared to show an inverse relationship for all course categories, save honors math.

TABLE XXVI

GIRLS' SCORES

	Average Student Survey Score	Math Total-Core	Math Total-Honors	Science Total-Core	Science Total-Honors
Average Student Survey Score	1				
Math Total-Core	.038	1			
Math Total-Honors	.168*	.266**	1		
Science Total-Core	.50	.026	-.035	1	
Science Total-Honors	.008	-.023	-.017	.038	1

Note. *Correlation is significant at the 0.05 level (2-tail); **Correlation is significant at the 0.01 level (2-tail).

TABLE XXVII

BOYS' SCORES

	Average Student Survey Score	Math Total-Core	Math Total-Honors	Science Total-Core	Science Total-Honors
Average Student Survey Score	1				
Math Total-Core	-.170**	1			
Math Total-Honors	.177**	-.005	1		
Science Total-Core	-.040	.084	.068	1	
Science Total-Honors	-.138	.138	-.096	.37**	1

Note.*Correlation is significant at the 0.05 level (2-tail); **Correlation is significant at the 0.01 level (2-tail).

In addition to exploring the number of math and science courses students have already taken, they were asked to anticipate how many math and science courses they might want to take in the future. Because all of the subjects in the study were sophomores and juniors, it is plausible to imagine that any subsequent math and science courses would exceed the minimum graduation requirement of 2 years of math and 2 years of science. An evaluation of intentions for taking math and science courses indicated a positive relationship with the STEM Career Self-Efficacy Test (SCS-ET) and STEM Career Interest Test (SCIT; Table X). Although both are significant at the p = .01 level, the relationships are considered weak, with future math courses (r = .127, n = 436), and future science courses (r = .141, n = 577).

TABLE XXVIII

EVALUATION OF PROJECTED COURSES

	Average Student Survey Score	Future Math Total	Future Science Total
Average Student Survey Score	1		
Future Math Total	.127**	1	
Future Science Total	.141**	.579**	1

Note. *Correlation is significant at the 0.05 level (2-tail); **Correlation is significant at the 0.01 level (2-tail).

The relationship between future courses and self-efficacy and interest was further examined by controlling for sex. In both the cases of the future math and science courses, girls indicated a stronger positive correlation than did boys, as illustrated in Table Y. For the boys, the relationship between the mean scores and future math scores was marginal and insignificant (r = .07, n = 192), and for science just slightly stronger (r = .120, n = 266, $p < .05$). By contrast, the girls showed a slightly but significantly stronger positive correlation for math (r = .169, n = 238, $p < .01$) and science (r = .227, n = 305, $p < .01$).

TABLE XXIX

FUTURE COURSES, SELF-EFFICACY, AND INTEREST FOR BOYS

	Average Student Survey Score	Future Math Total	Future Science Total
Average Student Survey Score	1		
Future Math Total	.070	1	
Future Science Total	.120**	.719**	1

Note. *Correlation is significant at the 0.05 level (2-tail); **Correlation is significant at the 0.01 level (2-tail).

TABLE XXX

FUTURE COURSES, SELF-EFFICACY, AND INTEREST FOR GIRLS

	Average Student Survey Score	Future Math Total	Future Science Total
Average Student Survey Score	1		
Future Math Total	.169**	1	
Future Science Total	.227**	.403**	1

Note. *Correlation is significant at the 0.05 level (2-tail); **Correlation is significant at the 0.01 level (2-tail).

4.5 Conclusion

This chapter provided data analysis for the central research question. Data were used to analyze the degree to which a STEM-related message impacted student STEM self-efficacy and interest, as measured by the STEM Career Self-Efficacy Test (SCS-ET) and STEM Career Interest Test (SCIT). The next chapter provides a more thorough explanation of the results as well as conclusions, limitations, and implications for the future.

5. DISCUSSION AND IMPLICATION

The purpose of this study was to explore the manner in which social models impact STEM self-efficacy and interest. The intention was to examine whether model manipulation can provide some insight into ways to bolster female pursuit of STEM-related degrees and professions.

Research suggests that the presence of social models impacts the behavior of the observer (e.g., Luszczynska & Schwatrz, 2005). Bandura's (1999) social cognitive theory explains human functions in terms of a triadic reciprocity, a system that assumes human action is the result of an interaction among three variables: environment, behavior, and personal affect. A variation in any of the components creates a change in the model. Triadic reciprocity posits that individuals actively make choices about what environmental components they attend to, what value they place on those events, and how they organize those observations for future use. Using triadic reciprocity as a fundamental structure, we can then speculate that change in an environment via the presence of a social model can impact personal affect, such as self-efficacy and interest, and in turn adjust behavior. It is on the basis of this very assumption that this project is stipulated: Adjusting the environment via manipulations of a social model may alter student STEM interest and self-efficacy.

The study was designed specifically to examine whether and how variations in types of models can impact STEM self-efficacy and interest. In order to examine the different factors that may make a model more utilitarian, four fictional model profiles were created with four different model treatments: gender of the model (male/female), attractiveness of the model (average/above average), gender of the language used (feminine/masculine), human interest component (included/excluded).

5.1 Results

The results showed that different types of messaging via model profiles can, in fact, make a difference in high school students' interest and self-efficacy in STEM. Model gender, model attractiveness, and gendered language all impacted students' responses, which in turn varied according to gender of the student.

That models influenced self-efficacy and interest is not surprising and supports the larger literature on the subject. Models are integral to our decision making process (Bandura, 1999) as we examine the behaviors of those around us, make value judgments about the utility of those behaviors, and then respond accordingly. In this way, models serve as a conduit for our decision making process by either enhancing or abating our own confidence in performing the task at hand (Bandura, 1986). As such, the fact that student self-efficacy and interest varied in accordance to model exposure is predictable.

The most obvious observation is the overall difference in the mean scores between boys and girls, with boys reporting a higher self-efficacy and interest. With the response set on a 1-5 Likert scale and a score of 3 representing feelings of neutrality toward STEM, the boys' scores ranged from 2.47 to 2.98, illuminating that even those boys who were least interested anchored around the point of neutrality rather than adversity toward STEM. For the female participants, however, the data illustrate a less rosy picture, with the confidence and interest scores ranging between 2.13 and 2.7, suggesting that, on average, even those girls who scored the highest never committed to feelings of neutrality, let alone expressed confidence or interest. The results confirm the literature that extensively discusses the difference in STEM efficacy and interest between the sexes (e.g., Dawson, 2000; Kahle & Rennie, 1993). Boys are almost canonically more interested and assured in their math and science capabilities, regardless of true ability.

5.1.1 Profile Variations: Language

Next, profile variations were examined to determine which, if any, made a difference in student STEM interest and self-efficacy. The profiles viewed by the students differed on the basis of four variables, one of which was gendered wording and the incorporation of masculine- and feminine-themed words. Masculine words were those that are traditionally associated with male stereotypes, such as *leader, competitive,* or *dominant.* Female wording included words generally associated with female stereotypes, such as *support, understand,* and *interpersonal* (Gaucher, Friesen, & Kay, 2011). Results show that female language was perceived more positively than male language for all students, boys and girls, and for nearly all treatment combinations: female and male models and attractive and average looking models.

The fact that both boys and girls responded positively to the use of female language is of tremendous importance. These results reflect the importance of language and the care that must be taken when discussing fields that may traditionally be considered masculine. Because gender is one of the utmost salient social categories (e.g., Fiske, 1993) and is part of children's self-concept from very early on (e.g., Leaper & Bigler, 2011; Ruble, Martin, & Berenbaum, 2006), children use gender as a basic category to judge whether or not a particular career is personally desirable (Vervecken et al., 2013). How we use language to describe occupations influences women and men's gendered perceptions of those occupations (Stahlberg, Braun, Irmen, & Sczesny, 2007, for a review) and women's interest in male occupations (e.g., Bem & Bem, 1973; Born & Taris, 2010; Gaucher et al., 2011; Stout & Dasgupta, 2011). Although research has shown that the use of gender-fair language in descriptions of stereotypically male jobs generally strengthens girls' interest in stereotypically male occupations, the results from this study suggest that the phenomena applies to the male subjects, as well.

Gendered language is a much broader phenomenon than just making explicit diction choices. The literature documents language-lined gender stereotypes (e.g., Glick & Fiske, 1996) and differences in the way men and women use everyday language (e.g., Pennebaker, Mehl, & Niederhoffer, 2003). Women are perceived as more communal and interpersonally oriented than men, whereas men are accredited with traits such as leadership and agency (Eagly & Karau, 1991; Gaucher et al., 2011). Moreover, gender differences in the linguistic style of everyday speech are well documented (Carli, 1990). Women, for example, use a more communal style of speech than men (Brownlow, Rosamond, & Parker, 2003; Leaper & Ayres, 2007) and make more references to social and emotional words (Newman, Groom, Handelman, & Pennebaker, 2008). Although these nuances of language were not explored in the study, they lend themselves to further exploration into whether the utilization of what has generally been branded as female speech can enrich the educational experiences of not just girls but boys as well.

While it is no surprise that girls would react favorably to profiles utilizing feminine language, what is more interesting is not why female language appeals to girls, but why it did not deter the boys. With a sole exception, boys, just like girls, displayed a preference for femininely worded profiles. Masculinely worded profiles reported lower efficacy and interest compared with the same types of profiles with feminine wording. This finding suggests that masculine wording in reference to STEM, whether intentional or not, does not so much recruit boys to STEM, but rather serves to keep women out of the areas that men typically occupy.

That is not to say that the manner used to describe STEM or other traditionally male fields are malevolently orchestrated to exclude female participation, just that those institutional procedures, when inconsiderate of language, are likely to have a discriminatory effect even if there is no discriminatory intent. Unlike in the decades past, when we explicitly ushered female students toward home economics, today people have explicit directives and genuine goals to gender diversify the field of STEM. But we must be cognizant of whether or not gendered wording emerges through motivational biases that operate outside people's awareness. Regardless of whether gendered wording is deliberately used, the data suggest that as it pertains to STEM, masculine wording can dissuade interest and efficacy in STEM.

All of this can and should be leveraged into classroom practice. Schools are making great strides to apply measures to ameliorate the decline of female interest in STEM, and special attention should be paid to the manner in which teachers engage in discourse, provide feedback, and generally navigate the curriculum. The explicit application of female language in instruction, teaching materials, and recruitment materials can enhance not only the girls' but also the boys' interest and efficacy toward STEM, as feminine language is effective for both genders. The utility of this is that it eliminates the need for specialized instruction tethered to a specific gender and allows for more pedagogical universality. This also mitigates any instructional mismatches for students whose biological sex may not match their gender identity. Using female language ubiquitously will yield the greatest win.

5.1.2 Profile Variations: Physical Attractiveness

Regarding the physical appearance of the models, in general, attractive models were less positively perceived by all students, both boys and girls, than average looking models. This was a somewhat unpredictable outcome. The literature on beauty suggests that we ascribe more favorable character traits to people who are attractive than those who are not. That is, we make more favorable assumptions about both their personal and professional lives (Dion et al., 1972) and also perceive them to be more familiar (Monin, 2003). In the design, the assumption was made that because attractive people are viewed to be in possession of desirable characteristics, then they would serve as conduits for interest and efficacy enhancement because the student subject would want to emulate those desirable traits.

This, however, proved to be too simplistic of an assumption, especially when viewed in the light of the literature on modeling. Although it may be that the "what is beautiful is good" (Dion et al., 1972) axiom is true, an attractive model does not necessarily translate into an effective one. That is because for a social model to be persuasive, the model must be relatable (Cherian et al., 2011). Therefore, if a model possesses traits that are vastly different from the agent, the model becomes less relatable and the achievements of the model too untenable to be in any way persuasive. This suggests that if a student viewed herself as average looking, then a social model who is too attractive is simply not relatable enough and any efforts to influence efficacy or interest will prove impotent.

This would be a tidy explanation for why average looking models resulted in higher mean scores, if people didn't struggle with illusionary superiority (e.g., Hoorens, 1995; Hoorens & Harris, 1998) and view themselves as more attractive than they actually are (Epley & Whitchurch, 2008). However, while people may tend to view themselves as above average, they prefer to look at faces that better reflect averages than outliers. In other words, despite the preternatural beauty of models on the billboards and in the glossy pages of magazines, we mostly prefer looking at average looking folks (Halberstadt & Rhodes, 2000).

This is, of course, a tremendous relief to those of us who stand in front of students all day and who plan to design STEM recruitment and retention materials. Classroom materials can be populated by real people, as opposed to idealized models, and research can be focused on identifying characteristics that will make those materials relatable to students. The most successful approach may be to identify models who exhibit characteristics valued by students and thus offer feasible paths to success in STEM.

5.1.3 Profile Variations: Interaction Effects

When profile components were examined in combination with each other, girls showed a connection between gendered language, model gender, and attractiveness. That is, when the model was an attractive male, then male language was viewed more favorably than female language. When the model was an attractive female, then female language was viewed more favorably. Considered another way, girls struggled when there was an incongruity between the gender of the model and the gender of the language, when the model was attractive. Specifically, female language in attractive male models and male language in attractive female models were both viewed as the most unfavorable conditions.

Boys, like girls, found that attractive female models using male language were the least favored condition, but attractive male models were perceived equally whether they used female language or male language. These observations leave more questions than answers. Why does the mismatch between model sex and model language yield such adverse reactions? Why, specifically, are attractive female models using male language so susceptible to negative response? And although gender stereotyping victimizes both men and women, are there gender differences in terms of which gender is more susceptible to being stereotyped and by whom?

There is work being done that suggests women who wish to advance professionally are subject to a catch-22: If they exhibit stereotypically masculine qualities and strive for advancement, they are viewed as competent but not nice, thus creating a very distinct dichotomy between masculinity and competence and femininity and niceness. It is not beyond a reasonable doubt that by the time boys and girls reach high school they have already absorbed and are adhering to gender stereotypes, even those that have been observed in the professional world. If girls perceive female language as “nice,” are they concerned with being nice rather than being competent? Do they not only adhere to gender stereotypes themselves but expect other women to behave in a similar manner? Why did both boys and girls expect women, especially attractive women, to adhere to stringent gender roles, and what social stereotype is this illustrating?

In making recommendations for the development of recruitment materials, it would seem that using an average looking model with female language yields the most beneficial results. Average looking models were least susceptible to variability in the results, and if recruitment materials were to err in the application of gendered language to an attractive model, then the adverse effects are simply too great.

5.1.4 Race

When the results were grouped by race, no statistical difference was noted. First, there were no differences in interest and efficacy by race. Second, race did not impact the way the students responded to the treatments. Third, there was no significant interaction between race and gender – that is, there was no evidence that boys and girls within each race responded differently.

However, there are notable limitations. First, African American students were left out of the analysis due to low sample size. Second, the population of Asian and Asian American students scored much higher than the other populations observed, but the limited sample size and low statistical power may have thwarted any statistical significance. As such, although no difference was observed among the races, that conclusion is made murky by the possibility of a Type II error.

This raises the question of whether inclusion of a pretest would have illustrated an appreciable gain or loss in STEM self-efficacy and interest as a result of the intervention. In the case of the Asian or Asian American population, the literature supports an expectation of excelling in STEM (Bempechat & Drago-Severson, 1999; Bempechat et al., 1996; Center on Education Policy, 2010); therefore, the high self-efficacy and interest scores are not surprising. However, no conclusions can be drawn about the overall change in scores as a result of the intervention for that racial group, or any other.

The sample size was robust enough, however, to illustrate no significant difference between the Hispanic and Caucasian students. This seems to run counter to the literature suggesting that, on average, Hispanic and Latino students show a lower math and science efficacy than their Caucasian counterparts (NCES, 2011). In this instance, the racial differences may be obfuscated by the socioeconomic environment in which the schools reside. Underperformance of low-income students (e.g., Croizet & Claire, 1998) is an unfortunate axiom. At the time the study was conducted, 48.5% of the students qualified for free and reduced lunch. Of that, 21% were Caucasian and 73% self-identified as Hispanic or Latino/a. As such, income may have been an unforeseen but influential variable.

There is an important message here—at least for Caucasian and Hispanic or Latino/a students—that the messaging conclusions should work for both populations, at least for those who come from a background similar to the population from which this sample was pulled. That is good news, as it allows for broad applicability of intervention and instruction.

5.1.5 <u>Birth Order</u>

The results illustrate that last-born children demonstrated a stronger sense of self-efficacy than first-born children. However, there were no significant interactions between birth order and the treatment effects; so while birth order may influence STEM interest and self-efficacy, it had no effect on how students responded to the model variations. In families with two or more children, the youngest children showed the strongest interest and self-efficacy in STEM. When filtering this through the lens of social cognitive theory, the explanation may be in the opportunity that younger children have to observe the behaviors of their older siblings. The youngest children can then make decisions about their personal choices based on the modeled behaviors and subsequent consequences.

It is important, however, not to over account and assume a causal explanation. Nor is it wise to fixate on this particular fact. For one, the question did not account for family structures. It may be a very different phenomenon to be the older of two than it is to be the youngest of eight. There is no identifier to determine the size of the respondents' family. Because the social environment a child experiences changes in the presence and absence of siblings (Downey, 2001), in this instance, it is very difficult to determine the degree to which a child's interest and efficacy in STEM is affected by their birth order. Although the relationship between birth order and intelligence is of high interest to the research community, there is little consensus in methodology or interpretation of results (Rogers, 2001).

5.1.6 Parents in Science, Technology, Engineering, and Mathematics

The literature supports an expectation that the presence of a STEM role model significantly improves how girls perceive their own ability to succeed in a STEM field (e.g., Cherian et al., 2011). Therefore, it was hypothesized that students who had one or two parents in a STEM field would have significantly higher STEM interest and efficacy. However, that proved an unsubstantiated assumption. The first thing worth noting is that although the means suggest that having parents in STEM predicts a more enhanced self-efficacy and interest, those differences were not significant and therefore cannot be attributed to parent profession. This was an unexpected result and in direct opposition to the recent work of Anaya, Stafford, and Zamarro (2017), who suggested that the presence of even one parent in a STEM field increased the likelihood of female enrollment in college science programs, such as engineering, math, and computer science. Anaya et al. also found that the effect of a parent in STEM is larger for girls than for boys.

The positive impact of a STEM parent is in line with the work on the potential benefit of role models on women. It could also serve as a catalyst for breaking down gender stereotypes and poor self-assessments of personal ability.

As noted earlier, the results are enigmatic. An increase in mean scores was predicted but was not statistically significant. Because males failed to experience an increased sense of efficacy and interest in the presence of a second STEM parent, the exploration of parent gender in STEM was especially interesting. Some of this variation may be explained by the racial distribution of the student sample. Livingston (2013) found that Hispanic mothers were far more likely than non-Hispanic mothers to stay home, as they believed their children were better off with a parent at home to focus on the family. With over 60% of the student sample self-identifying as Latino or Hispanic, simply the presence of a working mother, regardless of vocational field, may be a cultural anomaly and thus result in a negative perception on the part of the boys. This explanation, however plausible, is somewhat weakened by the results of the subsequent section.

5.1.6.1 Mom or Dad in Science, Technology, Engineering, and Mathematics

When taking this examination one step further and looking at whether it is the mom or the dad who work in a STEM-related field, the results generate more questions than answers. For example, male students reported a higher self-efficacy and interest in STEM when they had a mom in STEM rather than a dad, and girls reported a higher self-efficacy and interest in STEM when they had a dad in STEM rather than a mom.

At first blush, this appears to contradict the theories on salience of similar models. We would assume that females would find mothers more similar and males would find fathers more similar, in each case predicting a more enhanced efficacy and interest. Again, perhaps other forces are at play that merit consideration. For example, perhaps for adolescent males, relationships with mothers are more consequential than with fathers? The father, as a figurehead, may be too removed from the daily minutia of the family life and may be too distant to be relatable. Similarly, for female students, if the mother of the house has broken gender stereotypes and participates in the STEM field, she may be all the more difficult for the female student to relate to. By contrast, a father in STEM may be a predictable gender role.

5.1.6.2 **Mothers in Science, Technology, Engineering, and Mathematics**

In the exploration of parents in STEM, a new salient variable emerges. For the first time, human element is identified as a significant treatment effect. When examining mothers in STEM, the significant interaction among model attractiveness, profile language, and human element must be unpacked. First, we observe that if the language is female, variations in human element are not significantly different regardless of model attractiveness. However, when the language is male, the differences are both significant and rich for analysis.

It is notable that when using male language, if the model is attractive, the inclusion of the human element has an adverse impact on the outcomes of self-efficacy and interest scores. By contrast, if the model is average looking, it is the lack of the human element that has the adverse reaction—and a deeply meaningful one. It is worth remembering that this particular segment of the sample has a female STEM model at home. As such, when the language is female, it matches with what the subject would expect—the same sort of language his home-based STEM model uses. This may negate the impact of other variables. However, when the language is in discord with what the subject would expect, he is more sensitive to the other variables.

The inclusion of a human element for average looking models appears to correlate with strong efficacy and interest. Is it possible that a human connection to the STEM subject makes the model more relatable and therefore more effective? If people tend to learn from those models who resemble them closely or who match their ideal image (Bandura, 1986; Mussweiler, 2003; Schunk et al., 1987; Wood & Bandura, 1989), could it be that it is humanitarian efforts, rather than physical attractiveness that better reflect an idealized self-image? By contrast, an attractive STEM model with a human component indicates a completely opposite result, with a diminutive efficacy and interest score. We may posit that students may view an attractive model who also does substantively good works as simply too distant to be relatable, their accomplishments being too out of reach to be plausible for a high school student. The concept of unattainable models was the subject of a recent study by Aish, Asare, and Miskioğlu (2017) who suggest that extraordinary role models do not represent a feasible path to success for students who perceive themselves as underrepresented. Their work proposes the creation of more accessible STEM models who exhibit the qualities students seek in role models. This may reflect student sensitivity to attractive profiles.

5.1.6.3 **Fathers in Science, Technology, Engineering, and Mathematics**

When considering dads in STEM, we again take into consideration that the student already has a proximal STEM model: the father. An examination of the interaction between profile sex and language gender suggests that when the scientist profile is female, the use of female language reflects greater self-efficacy and interest than male language. This alignment between language and profile is understandable: If having a father in STEM makes depictions of female STEM role models more unique and subsequently more noteworthy of scrutiny, we might imagine that subjects expect females to use female language. If models do not conform to expectations, the bridge between subject and model may be more difficult to cross.

The examination of intersection between profile gender and human element highlights an interesting result as well. When a profile contains a human element and the language is female, the self-efficacy and interest score is almost a 3. By contrast, when a profile contains a human element and the language is male, low self-efficacy and interest scores are observed. When there is no human interest included, language differences do not result in statistically different efficacy and interest scores.

In considering explanations, we must keep in mind the paradigm of our subjects. When looking at subjects with a father in STEM, the subject observes a model in a traditionally stereotypical situation. With female language generally considered more affective (Mulac, Bradac, & Gibbons, 2006), the student subject might reasonably associate female language with the pursuit of doing good, and thus the human component in the profile becomes more salient. Therefore, when the human element and female language align, the model is perceived as more “accurate” and more relatable. By contrast, the model becomes less accurate, less relatable, and consequently less effective when it fails to align female language patterns and instead utilizes male language when employing a human element.

Reflecting on the subject’s father in STEM, the subject may expect a model not to be engaged in a human element related field and would therefore be less sensitive or responsive to variations in language. In considering the presence of human interest as a variable of influence, it is important to consider the fact that the human element present in the profiles was not only medical in nature but also included a reference to pediatrics. As the field of medicine does not suffer from a dearth of female participants, subjects may have an association of women healing and caring for children. As such, they would be looking for alignment between female language and human element.

The last question to ponder is simply why this treatment is only significant when considering parents in STEM? Is there something about the egalitarian household that makes humanitarian efforts more salient? Although this study does not provide an answer, it may be of interest for subsequent research.

5.1.7 Post-Secondary Intent

When we examine the subject's intended educational plans following high school graduation, the only significant difference was between students who had no plans to attend college, or weren't sure about their plans, and students who intended to enroll in a four-year institution. The students with four-year aspirations reported a higher STEM self-efficacy and interest than students with no, or uncertain, collegiate aspirations. This was not an unexpected finding. Students with college plans already believe they are capable of succeeding on an advanced academic level, which is likely to include STEM-related courses. What is worth noting, however, is only 52% of undergraduate students who intend to complete a STEM-related major stay the course. Roughly half of those who left the STEM pipeline switched to a non-STEM major, while the rest left the STEM field by leaving college before earning a degree (X. Chen, 2013). Consequently, college bound students who may indicate high degrees of efficacy and interest in STEM while in high school, and who may even intend to pursue it in college, do not necessarily complete a STEM-related course of study.

Subjects who do not wish to pursue advanced degrees may have already decided they are not suited for academic rigor and may be biased against academic pursuits in general. What is more interesting, however, is the lack of significance for the two-year group. In 2017, 31.5% of students who originally enrolled in a community college transferred to a four-year institution within six years (Shapiro et al., 2017). However, the National Center for Education Statistics reports that 69% of community college students who declare STEM as a major don't complete that degree (X. Chen, 2013). This is a higher rate of attrition than for students who enroll immediately in a four-year institution. In discussing female participation in STEM, it is important to take note not only of their entry into the field but also their tenacity to stay there.

5.1.8 Math and Science Courses

The discussion of math and science courses taken, as well as intention to take future math and science courses, is germane to the topic of efficacy and interest, as math and science performance in high school is a reliable predictor of subsequent STEM pursuits (Betz, 1994). For that reason, it is in no way a surprise to identify a significant, albeit small, positive relationship between honors math courses taken and the average efficacy and interest scores. The negative correlation between core math courses and efficacy and interest is also not surprising, as the two disciplines are a graduation requirement and hardly reflective of student choice, autonomy, or interest. What *is* interesting, however, is the significant negative correlation between honors science courses and mean survey scores for the male student population, suggesting that the greater the number of honors science courses taken, the less male students are efficacious and interested in STEM careers. This is a highly unexpected result, as math and science performance, interest, and attitudes are highly related and frequently confounded in the literature. The very moniker STEM blends the two into a singularity. And yet, the correlation is negative. Little can be offered in terms of an explanation. Twenty percent of the honors science course teachers in the year this study was completed were women, so it is possible that the male students did not identify with the female teacher and thus had negative perceptions of the discipline. The other explanation that may be plausible is the increase of female students in honors level science courses. One might hypothesize that attending a class that is not dominated by one's own sex may threaten a male student's sense of belonging, thus explaining a possible decline in efficacy and interest.

5.1.9 Examination of the Instrument

The experiment consisted of students viewing a fictional STEM profile and then self-reporting on a number of items that were intended to reflect their STEM interest and self-efficacy. The scale was borrowed from the work of Milner et al. (2014). Although self-efficacy and interest are moderately correlated, they are considered to be very much distinct constructs (Rottinghaus et al., 2003). However, the students did not interpret them that way, seeing no discernable difference between the two. As such, it became impossible to discuss whether the intervention and what combination of profile components made a difference in their self-efficacy or in their interest. This is somewhat problematic because in making efforts to ameliorate female disinterest, one should have a clear objective. Although there is a relationship between self-efficacy and interest, it is still possible for a student to be highly efficacious and completely disinterested in a subject or task. For instance, I am quite firm in my ability to do laundry and wash dishes, yet I am not inclined to complete either.

The most likely flaw is with the design and use of an instrument initially developed with college students in mind. Moreover, although the undergraduates in the original study also conflated efficacy and interest, the survey may not have been brilliantly suited for teenagers. In subsequent research, it would be more beneficial to develop and pilot a scale specific to a high school sample.

5.2 Limitations of the Study

Findings from this research must be considered in light of the limitations of this study. The research was limited to 10th and 11th grade students at a significant juncture in their academic trajectory and decision making at this particular Midwestern suburban community. Other grade levels were not considered. Perceptions of student self-efficacy and interest were derived from a fictional scientist profile students read independently. There was no measurement of how long students spent on the profiles and whether they skimmed the information or read it to completion. Additionally, students were observed glancing at the computer screens of their tablemates and possibly contaminating the degree of influence of their own personal model.

Although attempts were made to gather an expansive demographic profile, various key factors were left unaccounted for, such as attendance rate, mobility rate, and parent level of education, that could affect perceptions of self-efficacy and interest. The student body in this sample is highly culturally and economically diverse, with 48.5% qualifying for free and reduced lunch, and consequently part of the historically underrepresented groups in the sciences; the study did not include this as a research variable. Variability in ethnicity, economics, and other demographics certainly play an important role, and given the paucity of research in this specific area of modeling, interest, and self-efficacy, the study aimed to be a step towards a richer understanding of the relationship between attractiveness and the self-efficacy of girls and women in STEM. Additionally, sample sizes for some of the different racial/ethnic groups were small and may have affected the analysis. This is particularly true for the Asian or Asian American subgroup.

It should be noted that the instrument used to assess student STEM self-efficacy and interest was originally developed for use with college students. Consequently, there is a possibility of items and questions being interpreted differently by the high school sample. The data may be subject to issues of validity in the event that the instrument is not appropriate for high school use.

Finally, there is always the potential that researcher bias may have colored the phenomenological interpretations of the results.

5.3 Conclusions and Future Work

On Tuesday, October 2, 2018, Donna Strickland became the third woman in history to win the Nobel Prize in Physics. Maria Goeppert Mayer won in 1963 for her work describing the structure of the atomic nucleus. Before that, Marie Curie won in 1903 for her role in the discovery of radiation. As soon at Strickland’s name was announced, a flurry of stories popped up on the Internet celebrating her win and lauding her achievements as exemplary of women’s accomplishments in the world of physics and other fields of science. What was unusual, however, is that despite her budding notoriety—and unlike her fellow male winners—Strickland didn’t have a Wikipedia page. A Wikipedia user had tried to set up a profile in May (Koren, 2018), but a moderator denied the posting, deeming Strickland not worthy of the publication. She was simply not important enough.

It is not just Wikipedia that deems the accomplishments of women unworthy of recognition. The history of the Nobel Prize itself is wrought with incidents of overlooking the contributions of women. Between the years of 1901 and 2017, 904 individuals were awarded the Nobel Prize. Of those, only 51 were women (The Nobel Foundation, 2018). While it should be noted that scientific discoveries take years to be recognized, as they need to be identified and validated, and there were far fewer female scientists 20 years ago than there are today, women are still routinely overlooked (Rathi, 2017).

Prominence is a vague concept to pinpoint, but in the world of academia it seems to hinge on awards won, societies headed, positions held, and pieces published. But in today's world, those recognitions are more commonly awarded to men. In fact, Marie Curie was initially overlooked for the Nobel, and it was only at the insistence of her husband that she was credited. That may have been 115 years ago, but today female academics still get less credit than their male teammates (Sarson, 2015). Women also give half the number of talks than their male peers (Nittrouer et al., 2018), cite their own research less frequently (King, Bergstrom, Correll, Jacquet, & West, 2017), and, as students, are generally regarded as less knowledgeable (Grunspan et al., 2016).

Frankly, this trope is tired. It is exhausting to hear about all of the spaces from which women are excluded and all of the ways in which they are relegated to second class citizenship. In 1857, Sarah Grimke wrote the following:

> Thus far woman has struggled through life with bandaged eyes, accepting the dogma of her weakness and inability to take care of herself not only physically but intellectually. She has held out a trembling hand and received gratefully the proffered aid. She has foregone her right to study, to know the laws and purposes of government to which she is subject. But there is now awakened in her a consciousness that she is defrauded of her legitimate Rights and that she never can fulfill her mission until she is placed in that position to which she feels herself called by the divinity within. Hitherto she has surrendered her person and her individuality to man, but she can no longer do this and not feel that she is outraging her nature and her God. (as cited by Lerner, 1985, p. 813)

Therefore, it is with some disappointment that in 2018, the conversation about incorporating more women in STEM is still garnering attention. It is incumbent upon us to be creators of opportunities and clearers of hurdles so that women and girls can take their rightful places as equal in the field of STEM and all the spaces into which they may want access. This study tries to contribute to the effort.

The purpose of the study was to identify factors that may increase the likelihood of female participation in STEM-related education and subsequent career trajectories. That models influence self-efficacy and interest is not surprising and supports the broader literature on the subject. Models are integral to our decision making process as we examine the behaviors of those around us, make value judgments about the utility of those behaviors, and then respond accordingly. Models serve as a conduit for our decision making process by either enhancing or abating our own confidence in performing the task at hand. As such, this study predicted that student self-efficacy and interest would vary in accordance to model exposure.

The results of the study show that high school student STEM self-efficacy and interest is malleable in the face of varying STEM messages. Additionally, the work suggests that some model qualities are valued more than others. As efforts are made to integrate girls into STEM-related fields, intense scrutiny must be applied to the type of model with which the girls are presented. The key to a successful model, it appears, is not that the model be conspicuously attractive or overwhelmingly accomplished, but rather that the model be relatable and adhere to general social boundaries and gender stereotypes. It is more important that girls see themselves in the model rather than view the model as an object of admiration. Social models should be prototypical, not anomalous, and should use inclusive, female gendered language. These recommendations held for boys and girls and both Caucasian and Hispanic high school students in this study.

This work yields opportunity for future exploration on multiple levels. The first is a more robust and expansive understanding of the role of language. It may behoove us to explore whether gendered language is perceived differently by young people than it is by adults. As adolescence is the apex of personality and identity development (e.g., Klimstra, 2014), how students internalize and judge gendered language may shed some light on the manner in which STEM should be discussed with young women. Moreover, the role of contextualizing math and science in a manner that highlights their social benefits may be an integral component to STEM outreach programs. In addition to working to disprove gender stereotypes and teaching girls varying STEM disciplines, in-school and out-of-school programs should consider highlighting the real world value of the disciplines. Schools need not be complacent and self-congratulatory when they see rising female enrollment in STEM courses; they need to make greater efforts to make sure the classroom environment is robust with STEM role models, be it by way of teachers, speakers, or simply posters. The ease of this is that even if teachers consciously make an effort to present STEM in such a way as to recruit girls, they don't have to worry about inadvertently leaving the boys behind.

What is so utilitarian about these findings is the simplicity in the application—meaning that there is no need to create separate recruitment materials for boys and girls. Because the data illustrate that boys respond positively to female language, recruitment materials can focus on girls, while at the same time benefitting the male student body.

The clearest takeaways from the study are these: the first is that language matters. Female language reflects themes of collaborative efforts rather than competition, whereas male language is more suggestive of independent achievement. As both male and female students respond positively to female language, it is necessary to explore the classroom environment. As pedagogical practices are explored, how much opportunity is there for kids to work collaboratively as opposed to being locked into competing among themselves? The second takeaway pertains to the current pedagogical darling, problem-based learning. Problem-based learning, if grounded in a human element, can play a role in the enhancement of self-efficacy and interest. Would it be so difficult to structure PBLs so as to anchor them around a topic of social betterment? I offer this as an example: I recently perused a physics textbook and came upon a chapter on reflection and refraction. The concept for refraction was paired with an illustration of a man bass fishing. The fisherman had thrown his lure into the water, and the line was split at the surface as an example of refraction. This is, of course, a perfectly adequate way to supplement an explanation on the topic. But I wonder to what degree a simple reworking of the narrative to show how refraction can be used to advance societal betterment would make a difference for the students in terms of their interest and self-efficacy? What is so elegant about these findings is that they are simple in their application and do not require tremendous efforts on the part of the teachers or school administrators. Small changes, if implemented correctly, have the potential to move students not only past the point of neutrality but hopefully toward a positive feeling toward STEM.

Tremendous progress has been made in achieving gender equality in the field of STEM. And yet, we are not quite there. In 2015, Isis Anchalee created the #Ilooklikeanengireer social media handle in response to accusations that she was too attractive to be an engineer. Her goal was to break stereotypes in the industry. It is only when we reach a point when such hashtags are irrelevant, and these movements are no longer a trend, that we can sit back and enjoy the benefits of inclusion and equality.

REFERENCES

Achter, J. A., Lubinski, D., & Benbow, C. P. (1996). Multipotentiality among the intellectually gifted:" It was never there and already it's vanishing.” *Journal of Counseling Psychology, 43*(1), 65. doi:10.1037/0022-0167.43.1.65

Ackerman, P. L., Kanfer, R., & Beier, M. E. (2013). Trait complex, cognitive ability, and domain knowledge predictors of baccalaureate success, STEM persistence, and gender differences. *Journal of Educational Psychology, 105*(3), 911-927. doi:10.1037/a0032338

Aharon, I., Etcoff, N., Ariely, D., Chabris, C. F., O’Connor, E., & Breiter, H. C. (2001). Beautiful faces have variable reward value: FMRI and behavioral evidence. *Neuron,* 32, 537-551. doi:10.1016/s0896-6273(01)00491-3

Aish, N., Asare, P., & Miskioğlu, E. E. (2017, October). People like me increasing likelihood of success for underrepresented minorities in STEM by providing realistic and relatable role models. In *Frontiers in education conference (FIE)* (pp. 1-4). Piscataway, NJ: Institute of Electrical and Electronics Engineers. doi:10.1109/fie.2017.8190454

Albright, L., Kenny, D. A., & Malloy, T. E. (1988). Consensus in personality judgements at zero acquaintance. *Journal of Personality and Social Psychology, 55*, 387-395. doi:10.1037//0022-3514.55.3.387

Alemayehu, B., & Warner, K. E. (2004). The lifetime distribution of health care costs. *Health Services Research, 39*(3), 627-642. doi:10.1111/j.1475-6773.2004.00248.x

Alexopoulou, E., & Driver, R. (1997). Gender differences in small group discussion in physics. *International Journal of Science Education, 19*(4), 393-406. doi:10.1080/0950069970190403

Anaya, L., Stafford, F., & Zamarro, G. (2017). Gender gaps in math performance, perceived mathematical ability and college stem education: The role of parental occupation. *EDRE Working Paper, 2017*(21). doi:10.2139/ssrn.3068971

Anderson, E. S., Winett, R. A., & Wojcik, J. R. (2007). Self-regulation, self-efficacy, outcome expectations, and social support: Social cognitive theory and nutrition behavior. *Annals of Behavioral Medicine, 34,* 304-312. doi:10.1007/bf02874555

Anderson, N., Lankshear, C., Timms, C., & Courtney, L. (2008). "Because it's boring, irrelevant and I don't like computers": Why high school girls avoid professionally-oriented ICT subjects. *Computers & Education*, *50*(4), 1304-1318. doi:10.1016/j.compedu.2006.12.003

Andreoni, J., & Petrie, R. (2008). Beauty, gender, and stereotypes: Evidence from laboratory experiments. *Journal of Economic Psychology,* 29, 73-93. doi:10.1016/j.joep.2007.07.008

Anthoine, E., Moret, L., Regnault, A., Sébille, V., & Hardouin, J. B. (2014). Sample size used to validate a scale: A review of publications on newly-developed patient reported outcomes measures. *Health and Quality of Life Outcomes*, *12*(1), 1. doi:10.1186/s12955-014-0176-2

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science aspirations, capital, and family habitus: How families shape children's engagement and identification with science. *American Educational Research Journal, 49*(5), 881- 908. doi:10.3102/0002831211433290

Archer, L., Dewitt, J., & Willis, B. (2014). Adolescent boys' science aspirations: Masculinity, capital and power. *Journal of Research in Science Teaching, 51*(1), 1-30. doi:10.1002/tea.21122

Ashmore, R. D., & Tumia, M. L. (1980). Sex stereotypes and implicit personality theory. I. A personality description approach to the assessment of sex stereotypes. *Sex Roles, 6*(4), 501-518. doi:10.1007/bf00287882

Baker, D., & Leary, R. (1995). Letting girls speak out about science. *Journal of Research in Science Teaching*, *32*(1), 3-28. doi:10.1002/tea.3660320104

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

Bandura, A. (1989). Regulation of cognitive processes through perceived self-efficacy. *Developmental Psychology, 25,* 729-735. doi:10.1037//0012-1649.25.5.729

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (Vol. 4, pp. 71-81). New York, NY: Academic Press.

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

Bandura, A. (1999). Social cognitive theory of personality. In L. A. Pervin & O. P. John(Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 154-196). New York, NY: The Guilford Press.

Bandura, A. (2001). Social cognitive theory of mass communication. *Media Psychology, 3*, 265-299. doi:10.1207/s1532785xmep0303_03

Bandura, A. (2011). Social cognitive theory. In Van Lange, P. A. M., Kruglanski, A. W., & Higgins, E. T. (Eds.), *Handbook of social psychological theories* (pp. 349-373). Thousand Oaks, CA: Sage.

Bandura, A., & Locke, E. A. (2003). Negative self-efficacy and goal effects revisited. *Journal of Applied Psychology*, *88,* 87-99. doi:10.1037/0021-9010.88.1.87

Banks, C. G., & Murphy, K. R. (1985). Towards narrowing the research-practice gap in performance appraisal. *Personnel Psychology, 38*(2), 335-345.

Barak, A., Shiloh, S., & Haushner, O. (1992). Modification of interests through cognitive reconstructioning: Test of a theoretical model in preschool children. *Journal of Counseling Psychology, 39,* 490-497. doi:10.1037//0022-0167.39.4.490

Bargh, J. A., & Chartrand, T. L. (1999). The unbearable automaticity of being. *American Psychologist*, *54*, 462-479. doi:10.1037/0003-066X.54.7.462

Barman, C. R. (1999). Completing the study: High school students' views of scientists and science. *Science and Children*, *36*(7), 16-21. Retrieved from https://www.nsta.org/elementaryschool/

Barnard, W. M. (2004). Parent involvement in elementary school and educational attainment. *Children and Youth Services Review*, *26*(1), 39-62. doi:10.1016/j.childyouth.2003.11.002

Baron, R. A. (1970). Attraction toward the model and model's competence as determinants of adult imitative behavior. *Journal of Personality and Social Psychology*, *14*(4), 345-351. doi:10.1037/h0028994

Barton, A. C. (1998). *Feminist science education*. New York, NY: Teachers College Press.

Baylor, A. L. (2011). The design of motivational agents and avatars. *Educational Technology Research and Development*, *59*(2), 291-300. doi:10.1007/s11423-011-9196-3

Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., & Doms, M. E. (2011). Women in STEM: A gender gap to innovation. *Economics and Statistics Administration Issue Brief*, *4*(11). doi:10.2139/ssrn.1964782

Behm-Morawitz, E., & Mastro, D.E. (2008). Mean girls: The influence of gender portrayals in teen movies on emerging adults‘ gender-based attitudes and beliefs. *Journalism & Mass Communication Quarterly, 85*, 131-146. doi:10.1177/107769900808500109

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences*, *107*(5), 1860-1863. doi:10.1073/pnas.0910967107

Bem, S. L., & Bem, D. J. (1973). Does sex- biased job advertising "aid and abet" sex discrimination? *Journal of Applied Social Psychology*, *3*(1), 6-18. doi:10.1111/j.1559-1816.1973.tb01290.x

Bempechat, J., & Drago-Severson, E. (1999). Cross-national differences in academic achievement: Beyond etic conceptions of children's understandings. *American Educational Research Association, 69*(3), 287-314. doi:10.3102/00346543069003287

Bempechat, J., Nakklua, M. J., Wu, J. T., & Ginsburg, H. P. (1996). Attributions as predictors of mathematics achievement: A comparative study. *Journal of Research & Development in Education*, *29*, 53-59.

Benbow, C. P., & Stanley, J. C. (1983). Sex differences in mathematical reasoning ability: More facts. *Science*, *222*(4627), 1029-1031. doi:10.1126/science.6648516

Bendels, M. H., Wanke, E. M., Benik, S., Schehadat, M. S., Schöffel, N., Bauer, J., & Groneberg, D. A. (2018). The gender gap in highest quality medical research: A scientometric analysis of the representation of female authors in highest impact medical journals. *Deutsche Medizinische Wochenschrift (1946), 143*(10), e85-e94.

Berry, D. S. (2000). Attractiveness, attraction, and sexual selection: Evolutionary perspectives on the form and function of physical attractiveness. *Advances in Experimental Social Psychology, 32*, 273-342. doi:10.1016/S0065-2601(00)80007-6

Berscheid, E., & Walster, E. (1974). Physical attractiveness. *Advances in Experimental Social Psychology, 7*, 157-215. doi:10.1016/s0065-2601(08)60037-4

Betz, N. E. (2004). Contributions of self-efficacy theory to career counseling: A personal perspective. *The Career Development Quarterly*, *52*(4), 340-353. doi:10.1002/j.2161-0045.2004.tb00950.x

Betz, N. E., & Borgen, F. H. (2000). The future of career assessment: Integrating vocational interests with self-efficacy and personal styles. *Journal of Career Assessment, 8,* 329-338. doi:10.1177/106907270000800402

Betz, N. E., & Hackett, G. (1981). The relationship of career-related self-efficacy expectations to perceived career options in college women and men. *Journal of Counseling Psychology*, *28*(5), 399-410. doi:10.1037/0022-0167.28.5.399

Betz, N. E., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior*, *23*(3), 329-345. doi:10.1016/0001-8791(83)90046-5

Betz, N. E., & Hackett, G. (1997). Applications of self-efficacy theory to the career assessment of women. *Journal of Career Assessment*, *5*(4), 383-402.

Betz, N. E., & Schifano, R. S. (2000). Evaluation of an intervention to increase realistic self-efficacy and interests in college women. *Journal of Vocational Behavior, 56,* 35-62. doi:10.1006/jvbe.1999.1690

Betz, D. E., & Sekaquaptewa, D. (2012). My fair physicist? Feminine math and science role models demotivate young girls. *Social Psychological and Personality Science*, *3*(6), 738-746. doi:10.1177/1948550612440735

Black, S. E., Grönqvist, E., & Öckert, B. (2018). Born to lead? The effect of birth order on noncognitive abilities. *Review of Economics and Statistics*, *100*(2), 274-286. doi:10.1162/rest_a_00690

Bleeker, M. M., & Jacobs, J. E. (2004). Achievement in math and science: Do mothers' beliefs matter 12 years later? *Journal of Educational Psychology*, *96*(1), 97-109. doi:10.1037/0022-0663.96.1.97

Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychological Review*, *15*, 1-40.

Bordens, K. S., & Abbott, B. B. (2002). *Research design and methods: A process approach*. New York, NY: McGraw-Hill.

Born, M. P., & Taris, T. W. (2010). The impact of the wording of employment advertisements on students' inclination to apply for a job. *The Journal of Social Psychology*, *150*(5), 485-502. doi:10.1080/00224540903365422

Bouffard-Bouchard, T. (1990). Influence of self-efficacy on performance in a cognitive task. *The Journal of Social Psychology*, *130*(3), 353-363. doi:10.1080/00224545.1990.9924591

Bouffard-Bouchard, T., Parent, S., & Larivee, S. (1991). Influence of self-efficacy on self-regulation and performance among junior and senior high-school age students. *International Journal of Behavioral Development*, *14*(2), 153-164. doi:10.1177/016502549101400203

Bregman, G., & Killen, M. (1999). Adolescents' and young adults' reasoning about career choice and the role of parental influence. *Journal of Research on Adolescence*, *9*(3), 253-275. doi:10.1207/s15327795jra0903_2

Brickhouse, N. W. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching*, *38*(3), 282-295. doi:10.1002/1098-2736(200103)38:3<282::AID-TEA1006>3.0.CO;2-0

Britner, S. L. (2008). Motivation in high school science students: A comparison of gender differences in life, physical, and earth science classes. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *45*(8), 955-970. doi:10.1002/tea.20249

Britner, S. L., & Pajares, F. (2001). Self-efficacy beliefs, motivation, race, and gender in middle school science. *Journal of Women and Minorities in Science and Engineering*, *7*, 269-283. doi:10.1615/jwomenminorscieneng.v7.i4.10

Britner, S.L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science and Teaching, 43,* 485-499. doi:10.1002/tea.20131

Brouwers, A., & Tomic, W. (2000). A longitudinal study of teacher burnout and perceived self-efficacy in classroom management. *Teaching and Teacher Education*, *16*(2), 239-253. doi:10.1016/S0742-051X(99)00057-8

Brown, S. D., Lent, R. W., & Larkin, K. C. (1989). Self-efficacy as a moderator of scholastic aptitude-academic performance relationships. *Journal of Vocational Behavior*, *35*(1), 64-75. doi:10.1016/0001-8791(89)90048-1

Brown, T., Cash, T., & Noles, S. (1986). Perceptions of physical attractiveness among college students: Selected determinants and methodological matters. *Journal of Social Psychology*, *126*, 305-316. doi:10.1080/00224545.1986.9713590

Brownlow, S., Rosamond, J. A., & Parker, J. A. (2003). Gender-linked linguistic behavior in television interviews. *Sex Roles*, *49*(3-4), 121-132. doi:10.1023/A:1024404812972

Bull, R., & Rumsey, N. (1988). *The social psychology of facial appearance*. New York, NY: Springer-Verlag.

Burkam, D. T., Lee, V. E., & Smerdon, B. A. (1997). Gender and science learning early in high school: Subject matter and laboratory experiences. *American Educational Research Journal*, *34*(2), 297-331. doi:10.2307/1163360

Burke, R. J., & Mattis, M. C. (Eds.). (2007). *Women and minorities in science, technology, engineering, and mathematics: Upping the numbers*. Cheltenham, England: Edward Elgar.

Campbell, J. R., & Connolly, C. (1987). Deciphering the effects of socialization. *Journal of Educational Equity and Leadership*, *7*(3), 208-222.

Cann, A., Siegfried, W. D., & Pearce, L. (1981). Forced attention to specific applicant qualifications: Impact on physical attractiveness and sex of applicant biases. *Personnel Psychology*, *34*(1), 65-75. doi:10.1111/j.1744-6570.1981.tb02178.x

Cardinal, B. J., & Sachs, M. L. (1995). Prospective analysis of stage-of-exercise movement mail-delivered, self-instructional exercise packets. *American Journal of Health Promotion*, *9*(6), 430-432. doi:10.4278/0890-1171-9.6.430

Carette, B., Anseel, F., & Van Yperen, N. W. (2011). Born to learn or born to win? Birth order effects on achievement goals. *Journal of Research in Personality, 45*, 500-503. doi:10.1016/j.jrp.2011.06.008

Cargile, A. C., & Bradac, J. J. (2001). 10 attitudes toward language: A review of speaker evaluation research and a general process model. *Communication Yearbook*, *25*, 347-382. doi:10.1080/23808985.2001.11679008

Carli, L. L. (1990). Gender, language, and influence. *Journal of Personality and Social Psychology*, *59*(5), 941-951. doi:10.1037/0022-3514.59.5.941

Carneiro, P., & Heckman, J. J. (2002). The evidence on credit constraints in post-secondary schooling. *The Economic Journal*, *112*(482), 705-734. doi:10.1111/1468-0297.00075

Cash, T. F., Gillen, B., & Burns, D. S. (1977). Sexism and beautyism in personnel consultant decision making. *Journal of Applied Psychology*, *62*(3), 301-310. doi:10.1037/0021-9010.62.3.301

Cavallo, A. M., & Laubach, T. A. (2001). Students' science perceptions and enrollment decisions in differing learning cycle classrooms. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 38*(9), 1029-1062. doi:1029-1062. 10.1002/tea.1046

Chambers, D. W. (1983). Stereotypic images of the scientist: The Draw- a- Scientist Test. *Science Education*, *67*(2), 255-265. doi:10.1002/sce.3730670213

Chemers, M. M., Hu, L. T., & Garcia, B. F. (2001). Academic self-efficacy and first year college student performance and adjustment. *Journal of Educational Psychology*, *93*(1), 55-64. doi:10.1037/0022-0663.93.1.55

Chen, A. H., Sallis, J. F., Castro, C. M., Lee, R. E., Hickmann, S. A., William, C., & Martin, J. E. (1997). A home-based behavioral intervention to promote walking in sedentary ethnic women: Project WALK. *Women's Health*, *4*(1), 19-39.

Chen, X. (2013). *STEM attrition: College students' paths into and out of STEM fields. Statistical analysis report* (NCES 2014-001). Washington, DC: National Center for Education Statistics.

Chen, X., & Weko, T. (2009). *Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education* (NCES 2009-161). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Cheryan, S., Drury, B. J., & Vichayapai, M. (2012). Enduring influence of stereotypical computer science role models on women's academic aspirations. *Psychology of Women Quarterly, 37*(1), 72-79. doi:10.1177/0361684312459328

Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? *Social Psychological and Personality Science*, *2*(6), 656-664. doi:10.1177/1948550611405218

Cheung, C., & Yue, X. D. (2003). Adolescent modeling after luminary and star idols and development of self-efficacy. *International Journal of Adolescence and Youth, 11*(3), 251-267. doi:10.1080/02673843.2003.9747932

Chimba, M., & Kitzinger, J. (2010). Bimbo or boffin? Women in science: An analysis of media representations and how female scientists negotiate cultural contradictions. *Public Understanding of Science*, *19*, 609-624. doi:10.1177/0963662508098580

Clifford, M., & Walster, E. (1973). The effects of physical attractiveness on teacher expectations. *Sociology of Education, 46*, 248-258. doi:10.2307/2112099

Cole, M. S., Feild, H. S., Giles, W. F., & Harris, S. G. (2009). Recruiters' inferences of applicant personality based on resume screening: Do paper people have a personality? *Journal of Business and Psychology, 24*(1), 5-18. doi:10.1007/s10869-008-9086-9

Concannon, J. P., & Barrow, L. H. (2010). Men’s and women’s intentions to persist in undergraduate engineering degree programs. *Journal of Science Education and Technology*, *19*(2), 133-145. doi:10.1007/s10956-009-9187-x

Cook, H., & Smothergill, D. W. (1973). Racial and sex determinants of imitative performance and knowledge in young children. *Journal of Educational Psychology, 65*(2), 211-215. doi:10.1037/h0034905

Correll, S. J. (2001). Gender and the career choice process: The role of biased self-assessments. *American Journal of Sociology*, *106*(6), 1691-1730. doi:10.1086/321299

Correll, S. J. (2004). Constraints into preferences: Gender, status, and emerging career aspirations. *American Sociological Review*, *69*(1), 93-113. doi:10.1177/000312240406900106

Cottrell, C. A., & Neuberg, S. L. (2005). Different emotional reactions to different groups: A sociofunctional threat-based approach to" prejudice.” *Journal of Personality and Social Psychology*, *88*(5), 770-789. doi:10.1037/0022-3514.88.5.770

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.

Croizet, J. C., & Claire, T. (1998). Extending the concept of stereotype threat to social class: The intellectual underperformance of students from low socioeconomic backgrounds. *Personality and Social Psychology Bulletin*, *24*(6), 588-594. doi:10.1177/0146167298246003

Crosnoe, R., Riegle-Crumb, C., Fields, S., Frank, K., & Muller, C. (2008). Peer group contexts of girls and boys' academic experiences. *Child Development*, *79*(1), 139-155. doi:10.1111/j.1467-8624.2007.01116.x

Cunningham, M. R. (1986). Measuring the physical in physical attractiveness: Quasi experiments on the sociobiology of female facial beauty. *Journal of Personality and Social Psychology, 50*(5), 925-935. doi:10.1037/0022-3514.50.5.925

Cunningham, M. R., Roberts, A. R., Barbee, A. P., Druen, P. B., & Wu, C. H. (1995). "Their ideas of beauty are, on the whole, the same as ours": Consistency and variability in the cross-cultural perception of female physical attractiveness. *Journal of Personality and Social Psychology*, *68*(2), 261-279. doi:10.1037/0022-3514.68.2.261

Dalgety, J., & Coll, R. K. (2006). The influence of first- year chemistry students' learning experiences on their educational choices. *Assessment & Evaluation in Higher Education*, *31*(3), 303-328. doi:10.1080/02602930500352931

Davalos, E., Mickelson, R. A., Moller, S., & Valentino, L. (n.d.). *Demographic representation in high school and STEM declaration in college* (Working paper). Retrieved from ROOTS of STEM Working Paper Series. (No. 100)

Dawson, C. (2000). Upper primary boys' and girls' interests in science: Have they changed since 1980? *International Journal of Science Education*, *22*(6), 557-570. doi:10.1080/095006900289660

Devine, A., Fawcett, K., Szucs, D., & Dowler, A. (2012). Gender differences in mathematics anxiety and the relation to mathematics and performance while controlling for test anxiety. *Behavioral and Brain Functions, 8,* 33-41. doi:10.1186/1744-9081-8-33

Dermer, M., & Thiel, D. L. (1975). When beauty may fail. *Journal of Personality and Social Psychology, 31*(6), 1168-1176. doi:10.1037/h0077085

Dey, J. G., & Hill, C. (2007). *Behind the pay gap*. Washington, DC: American Association of University Women Educational Foundation.

Dion, K. (2002). Cultural perspectives on facial attractiveness. In G. Rhodes & L. A. Zebrowitz (Eds.), *Facial attractiveness: Evolutionary, cognitive, and social perspectives* (pp. 239-259). Westport, CT: Ablex.

Dion, K., Berscheid, E., & Walster, E. (1972). What is beautiful is good. *Journal of Personality and Social Psychology*, *24*, 285-290. Doi:10.1037/h0033731

Dipboye, R. L., Arvey, R. D., & Terpstra, D. E. (1977). Sex and physical attractiveness of raters and applicants as determinants of resumé evaluations. *Journal of Applied Psychology, 62*(3), 288-294. doi:10.1037/0021-9010.62.3.288

Dipboye, R. L., Fromkin, H., & Wiback, K. (1975). Relative importance of applicant sex, attractiveness, and scholastic standing in evaluation of job applicant resumes. *Journal of Applied Psychology*, *60,* 39-43. doi:10.1037/h0076352

Downey, D. B. (1995). When bigger is not better: Family size, parental resources, and children's educational performance. *American Sociological Review*, *60*, 747-761. doi:10.2307/2096320

Downey, D. B. (2001). Number of siblings and intellectual development: The resource dilution explanation. *American Psychologist*, *56*(6-7), 497-504. doi:10.1037/0003-066X.56.6-7.497

Dryler, H. (1998). Parental role models, gender and educational choice. *British Journal of Sociology, 49,* 375-398. doi:10.2307/591389

Eagly, A. H., Ashmore, R., Makhijani, M., & Longo, L. (1991). What is beautiful is good, but. . . A meta-analytic review of research on the physical attractiveness stereotype. *Psychological Bulletin, 110*(1), 109-128. doi:10.1037//0033-2909.110.1.109

Eagly, A. H., & Karau, S. J. (1991). Gender and the emergence of leaders: A meta-analysis. *Journal of Personality and Social Psychology*, *60*(5), 685-710. doi:10.1037/0022-3514.60.5.685

Eagly, A. H., & Wood, W. (1991). Explaining sex differences in social behavior: A meta-analytic perspective. *Personality and Social Psychology Bulletin*, *17*, 306-315. doi:10.1177/0146167291173011

Eccles, J. S. (1994). Understanding women's educational and occupational choices. Applying the Eccles et al. model of achievement-related choices. *Psychology of Women Quarterly, 18*, 585-609. doi:10.1111/j.1471-6402.1994.tb01049.x

Eccles, J. S., & Harold, R. D. (1991). Gender differences in educational and occupational patterns among the gifted. In N. Colangelo, S. G. Assouline, & D. L. Amroson (Eds.), *Talent development: Proceedings from the 1991 Henry B. and Jocelyn Wallace National Research Symposium on talent development*. Unionville, NY: Trillim Press.

Eccles, J. S., & Jacobs, J. (1986). Social forces shape math attitudes and performance. *Signs: Journal of Women in Culture and Society, 11*, 367-380. doi:10.1086/494229

Eccles, J. S., Midgley, C., & Adler, T. (1984). Grade-related changes in the school environment. *The Development of Achievement Motivation*, *3*, 238-331.

Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (pp. 1017-1095). Hoboken, NJ: John Wiley & Sons.

Ecklund, E. H., Lincoln, A. E., & Tansey, C. (2012). Gender segregation in elite academic science. *Gender & Society*, *26*(5), 693-717. doi:10.1177/0891243212451904

Efran, M. G., & Patterson, E. W. J. (1974). Voters vote beautiful: The effect of physical appearance on a national election. *Canadian Journal of Behavioural Science*, *6*, 352-356. doi:10.1037/h0081881

Eisenhart, M., Finkel, E., & Marion, S. F. (1996). Creating the conditions for scientific literacy: A re-examination. *American Educational Research Journal*, *33*(2), 261-295. doi:10.3102/00028312033002261

Elliott, R., Strenta, A. C., Adair, R., Matier, M., & Scott, J. (1996). The role of ethnicity in choosing and leaving science in highly selective institutions. *Research in Higher Education, 37*(6), 681-709. doi:10.1007/bf01792952

Else-Quest, N. M., Hyde, J.,& Linn, M. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin*, *136*(1), 103-127. doi:10.1037/a0018053

Else-Quest, N. M., Mineo, C. C., & Higgins, A. (2013). Math and science attitudes and achievement at the intersection of gender and ethnicity. *Psychology of Women Quarterly, 37*, 293-309. doi:10.1177/0361684313480694

Epley, N., & Whitchurch, E. (2008). Mirror, mirror on the wall: Enhancement in self-recognition. *Personality and Social Psychology Bulletin*, *34*(9), 1159-1170. doi:10.1177/0146167208318601

Ethington, C. A. (2001). Differences among women intending to major in quantitative fields of study. *Journal of Educational Research, 81*(6), 354-359. doi:10.1080/00220671.1988.10885848

Eyal, K., & Kunkel, D. (2008). The effects of sex in television drama shows on emerging adults' sexual attitudes and moral judgments. *Journal of Broadcasting & Electronic Media, 52*, 161-181. doi:10.1080/08838150801991757

Farmer, H. S., Wardrop, J. L., Anderson, M. Z., & Risinger, R. (1995). Women's career choices: Focus on science, math, and technology careers. *Journal of Counseling Psychology*, *42*(2), 155-170. doi:10.1037/0022-0167.42.2.155

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2013). G* Power Version 3.1. 7 [computer software]. Uiversität Kiel, Germany.

Feather, N. T. (1988). Values, valences, and course enrollment: Testing the role of personal values within an expectancy-valence framework. *Journal of Educational Psychology*, *80*(3), 381-391. doi:10.1037/0022-0663.80.3.381

Feingold, A. (1992). Good-looking people are not what we think. *Psychological Bulletin*, *111*(2), 304-341. doi:10.1037//0033-2909.111.2.304

Feltz, D. L. (1988). Self-confidence and sports performance. *Exercise and Sport Science Reviews, 16*, 423-457. doi:10.1249/00003677-198800160-00016

Ferguson, P. D., & Fraser, B. J. (1998). Changes in learning environment during the transition from primary to secondary school. *Learning Environments Research*, *1*(3), 369-383. doi:10.1023/A:1009976529957

Field, A. (2009). *Discovering statistics using SPSS*. Thousand Oaks, CA: Sage.

Fink, B., Grammer, K., & Matts, P. J. (2006). Visible skin color distribution plays a role in the perception of age, attractiveness, and health in female faces. *Evolution of Human Behavior, 27,* 433-442. doi:10.1016/j.evolhumbehav.2006.08.007

Fink, B., Grammer, K., & Thornhill, R. (2001). Human (*Homo sapiens)* Facial attractiveness in relation to skin texture and color. *Journal of Comparative Psychology, 115,* 92-99. doi:10.1037//0735-7036.115.1.92

Fink, B., Matts, P. J., Klingenberg, H., Kuntze, S., Weege, B., & Grammer, K. (2008). Visual attention to variation in female facial skin color distribution. *Journal of Cosmetic Dermatology, 7,* 155-161. doi:10.1111/j.1473-2165.2008.00382.x

Finson, K. D., Beaver, J. B., & Cramond, B. L. (1995). Development and field test of a checklist for the Draw- A- Scientist Test. *School Science and Mathematics*, *95*(4), 195-205. doi:10.1111/j.1949-8594.1995.tb15762.x

Fiske, S. T. (1993). Social cognition and social perception. *Annual Review of Psychology, 44*(1), 155-194. doi:10.1111/j.1949-8594.1995.tb15762.x

Fiske, S. T., & Neuberg, S.L. (1990). A continuum of impression formation, from category based to individuating processes: Influences of information and motivation on attention and interpretation. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 23, pp. 1-74). New York, NY: Academic Press.

Fiske, S. T., Neuberg, S. L., Beattie, A. E., & Milberg, S. J. (1987). Category-based and attribute-based reactions to others: Some informational conditions of stereotyping and individuating processes. *Journal of Experimental Social Psychology*, *23*(5), 399-427. doi:10.1016/0022-1031(87)90038-2

Fiske, S. T., & Taylor, S. E. (2013). *Social cognition: From brains to culture.* Thousand Oaks, CA: Sage.

Fleming, N. (2018). How the gender pay gap permeates science and engineering. *New Scientist*, *237*(3167), 22-23. doi:10.1016/s0262-4079(18)30389-0

Flores, L. Y., & O'brien, K. M. (2002). The career development of Mexican American adolescent women: A test of social cognitive career theory. *Journal of Counseling Psychology*, *49*(1), 14-20. doi:10.1037//0022-0167.49.1.14

Fontenelle, G. A., Phillips, A. P., & Lane, D. M. (1985). Generalizing across stimuli as well as subjects: A neglected aspect of external validity. *Journal of Applied Psychology*, *70*(1), 101-107. doi:10.1037//0021-9010.70.1.101

Fort, D. C., & Varney, H. L. (1989). How students see scientists: Mostly male, mostly White, and mostly benevolent. *Science and Children*, *26*(8), 8-13.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (1993). *How to design and evaluate research in education* (Vol. 7). New York, NY: McGraw-Hill.

Fraser, B. J. (1998). Classroom environment instruments: Development, validity and applications. *Learning Environments Research*, *1*(1), 7-34. doi:10.4324/9780203097267.ch6

Gardner, P. L. (1998). The development of males' and females' interest in science and technology. In L. Hoffmann, A. Krapp, K. A. Renninger, & J. Baumert (Eds.), *Interest and learning: Proceedings of the Seeon-conference on interest and gender* (pp. 41-57). Kiel: Institut fuer die Paedagogik der Naturwissenschaften.

Gaucher, D., Friesen, J., & Kay, A. C. (2011). Evidence that gendered wording in job advertisements exists and sustains gender inequality. *Journal of Personality and Social Psychology, 101*(1), 109-110. doi:10.1037/a0022530

Gianakos, I. (1999). Patterns of career choice and career decision-making self-efficacy. *Journal of Vocational Behavior*, *54*(2), 244-258. doi:10.1006/jvbe.1998.1668

Gist, M., & Mitchell, T. (1992). Self-efficacy: A theoretical analysis of its determinants and malleability. *The Academy of Management Review, 17*(2), 183-211. doi:10.5465/amr.1992.4279530

Glick, P., & Fiske, S. T. (1996). The ambivalent sexism inventory: Differentiating hostile and benevolent sexism. *Journal of Personality and Social Psychology, 70*(3), 491-517. doi:10.43242F9781315187280-13

Goldman, W., & Lewis, P. (1977). Beautiful is good: Evidence that the physically attractive are more socially skillful. *Journal of Experimental Social Psychology, 13*(2), 125-130. doi:10.1016/s0022-1031(77)80005-x

Gordon, R. A., Crosnoe, R., & Wang, X. (2013). Physical attractiveness and the accumulation of social and human capital in adolescence and young adulthood: Assets and distractions. *Monographs of The Society for Research in Child Development*, *78*(6), 1-137. doi:10.1002/mono.12060

Graybill, L. (1975). Sex differences in problem- solving ability. *Journal of Research in Science Teaching*, *12*(4), 341-346. doi:10.1002/tea.3660120404

Grolnick, W. S., Ryan, R. M., & Deci, E. L. (1991). Inner resources for school achievement: Motivational Mediators of children's perceptions of their parents. *Journal of Educational Psychology, 83*(4), 508-517. doi:10.1037/0022-0663.83.4.508

Grunspan, D. Z., Eddy, S. L., Brownell, S. E., Wiggins, B. L., Crowe, A. J., & Goodreau, S. M. (2016). Males under-estimate academic performance of their female peers in undergraduate biology classrooms. *PloS One*, *11*(2), e0148405. doi:10.1371/journal.pone.0148405

Gunnell, J. J., & Ceci, S. J. (2010). When emotionality trumps reason: A study of individual processing style and juror bias. *Behavioral Sciences and the Law*, *28*, 850-877. doi:

Hackett, G., & Betz, N. E. (1981). A self-efficacy approach to the career development of women. *Journal of Vocational Behavior*, *18*(3), 326-339. doi:10.1002/bsl.939

Hackett, G., & Lent, R. W. (1992). Theoretical advances and current inquiry in career psychology. *Handbook of Counseling Psychology*, *2*, 419-452.

Halberstadt, J., & Rhodes, G. (2000). The attractiveness of nonface averages: Implications for an evolutionary explanation of the attractiveness of average faces. *Psychological Science*, *11*(4), 285-289. doi:10.1111/1467-9280.00257

Hamermesh, D. S., & Biddle, J. E. (1993). *Beauty and the labor market* (No. w4518). Washington, DC: National Bureau of Economic Research.

Hamermesh, D. S., & Biddle, J. (1994). Beauty and the labor market. *American Economic Review*, *84*, 1174-1194.

Hamermesh, D. S., & Parker, A. (2005). Beauty in the classroom: Instructors' pulchritude and putative pedagogical productivity. *Economics of Education Review*, *24*(4), 369-376. doi:10.1016/j.econedurev.2004.07.013

Hamilton, D. L, Stroessner, S. J., & Driscoll, D. M. (1994). Social cognition and the study of stereotyping. In P. G. Divine, D. L. Hamilton, & T. M. Ostrom (Eds.), *Social cognition: Impact on social psychology* (pp. 291-321). New York, NY: Academic Press.

Hand, B., McDermott, M., & Prain, V. (Eds.). (2016). *Using multimodal representations to support learning in the science classroom*. Switzerland: Springer International.

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science*, *23*(8), 899-906. doi:10.1177/0956797611435530

Hargittai, E., & Shafer, S. (2006). Differences in actual and perceived online skills: The role of gender. *Social Science Quarterly*, *87*(2), 432-448. doi:10.1111/j.1540-6237.2006.00389.x

Harlen, W. (1985). Girls and primary school education: Sexism, stereotypes and remedies. *Prospects*, *15*, 541-550. doi:10.1007/bf02197922

Hatfield, E., & Sprecher, S. (1986). *Mirror, mirror….* New York: State University of New York Press.

Häussler, P., & Hoffmann, L. (2002). An intervention study to enhance girls' interest, self-concept, and achievement in physics classes. *Journal of Research in Science Teaching*, *39*(9), 870-888. doi:10.1002/tea.10048

Heard, P. F., Divall, S. A., & Johnson, S. D. (2000). Can 'ears-on' help hands-on science learning for girls and boys? *International Journal of Science Education*, *22*(11), 1133-1146. doi:10.1080/09500690050166715

Heilman, M. E., & Saruwatari, L. R. (1979). When beauty is beastly: The effects of appearance and sex on evaluations of job applicants for managerial and nonmanagerial jobs. *Organizational Behavior and Human Performance*, *23*(3), 360-372. doi:10.1016/0030-5073(79)90003-5

Heilman, M. E., & Stopeck, M. H. (1985). Being attractive, advantage or disadvantage? Performance-based evaluations and recommended personnel actions as a function of appearance, sex, and job type. *Organizational Behavior and Human Decision Processes*, *35*(2), 202-215. doi:10.1016/0749-5978(85)90035-4

Hemphill, F. C., Vanneman, A., & Rahman, T. (2011). *Achievement gaps: How Hispanic and White students in public schools perform in mathematics and reading on the national assessment of education progress.* Retrieved from https://nces.ed.gov/nationsreportcard/pubs/studies/2011459.aspx

Herrera, N. C., Zajonc, R. B., Wieczorkowska, G., & Cichomski, B. (2003). Beliefs about birth rank and their reflections in reality. *Journal of Personality & Social Psychology*, *85*(1), 142-150. doi:10.1037/0022-3514.85.1.142.

Hidi, S., Renninger, K. A., & Krapp, A. (2004). Interest, a motivational construct that combines affective and cognitive functioning. In D. Dai & R. Stenberg (Eds.), *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development* (pp. 89-115). Mahwah, NJ: Erlbaum.

Hoffman, B., & Spatariu, A. (2008). The influence of self-efficacy and metacognition on math problem-solving efficiency. *Contemporary Educational Psychology, 33*, 875-893. doi:10.1016/j.cedpsych.2007.07.002

Hoffmann, L. (2002). Promoting girls' interest and achievement in physics classes for beginners. *Learning and Instruction*, *12*(4), 447-465. doi:10.1016/s0959-4752(01)00010-x

Holmgren, S., Molander, B., & Nilsson, L. G. (2006). Intelligence and executive functioning in adult age: Effect of sibship size and birth order. *European Journal of Cognitive Psychology*, *18*(1), 138-158. doi:10.1080/09541440500216150.

Hoorens, V. (1995). Self- favoring biases, self- presentation, and the self- other asymmetry in social comparison. *Journal of Personality*, *63*(4), 793-817. doi:10.1111/j.1467-6494.1995.tb00317.x

Hoorens, V., & Harris, P. (1998). Distortions in reports of health behaviors: The time span effect and illusory supefuority. *Psychology and Health*, *13*(3), 451-466. doi:10.1080/08870449808407303

Horn, L., Neville, S., & Griffith, J. (2006). *Profile of undergraduates in U.S. postsecondary education institutions: 2003–04*. Washington, DC: National Center for Education Statistics.

Hortz, B. (2008). Social cognitive theory variable mediation of moderate exercise. *American Journal of Health Behavior*, *32*, 305-314. doi:10.5993/ajhb.32.3.8

Hosoda, M., Stone-Romero, E., & Coats, G. (2003). The effects of physical attractiveness onjob-related outcomes: A meta-analysis of experimental studies. *Personnel Psychology, 56,* 431-462. doi:10.1111/j.1744-6570.2003.tb00157.x

Howes, E. V. (1998). Connecting girls and science: A feminist teacher research study of a high school prenatal testing unit. *Journal of Research in Science Teaching*, *35*(8), 877-896. doi:10.1002/(sici)1098-2736(199810)35:8<877::aid-tea5>3.0.co;2-r

Hutchison, M. A., Follman, D. K., Sumpter, M., & Bodner, G. M. (2006). Factors influencing the self-efficacy beliefs of first-year engineering students. *Journal of Engineering Education*, *95*(1), 39-47. doi:10.1002/j.2168-9830.2006.tb00876.x

Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in mathematics performance: A meta-analysis. *Psychological Bulletin*, *107*(2), 139-155. doi:10.1037//0033-2909.107.2.139

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Science*, *321*, 494-495. doi:10.1126/science.1160364

Hyde, J. S., & Mertz, J. (2009). Gender, culture and mathematics performance. *Proceedings of the National Academy of Sciences, 106*(22), 8801-8807. doi:10.1073/pnas.0901265106

Ilgen, D. R., & Favero, J. L. (1985). Limits in generalization from psychological research to performance appraisal processes. *Academy of Management Review*, *10*(2), 311-321. doi:10.5465/amr.1985.4278227

Jackson, L. A., Hunter, J. E., & Hodge, C. N. (1995). Physical attractiveness and intellectual competence: A meta-analytic review. *Social Psychology Quarterly, 58*(2), 108-122. doi:10.2307/2787149

Jacobs, J. E., & Eccles, J. S. (2000). Parents, task values, and real-life achievement-related choices. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance* (pp. 405-439). San Diego, CA: Academic Press. doi:10.1016/B978-012619070-0/50036-2

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self- competence and values: Gender and domain differences across grades one through twelve. *Child Development*, *73*(2), 509-527. doi:10.1111/1467-8624.00421

Johnson, S. K., Podratz, K. E., Dipboye, R. L., & Gibbons, E. (2010). Physical attractiveness biases in ratings of employment suitability: Tracking down the 'beauty is beastly' effect. *The Journal of Social Psychology*, *150*, 301-318. doi:10.1080/00224540903365414

Jones, B. C., Little, A.C., Burt, D. M., & Perrett, D. I. (2004). When facial attractiveness is only skin deep. *Perception*, *33*, 569-576. doi:10.1068/p3463

Jones, G. (1991). Gender differences in science competitions. *Science Education*, *75*(2), 159-167. doi:10.1002/sce.3730750202

Jones, M. G., Brader- Araje, L., Carboni, L. W., Carter, G., Rua, M. J., Banilower, E., & Hatch, H. (2000). Tool time: Gender and students' use of tools, control, and authority. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *37*(8), 760-783. doi:10.1002/1098-2736(200010)37:8<760::aid-tea2>3.0.co;2-v

Jones, M. G., Howe, A., & Rua, M. J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science Education*, *84*(2), 180-192. doi:10.1002/(sici)1098-237x(200003)84:2<180::aid-sce3>3.0.co;2-x

Kahle, J. B., & Lakes, M. (1983). The myth of equality in science classrooms. *Journal of Research in Science Teaching, 20*, 131-140. doi:10.1002/tea.3660200205

Kahle, J. B., & Rennie, L. J. (1993). Ameliorating gender differences in attitudes about science: A cross-national study. *Journal of Science Education and Technology*, *2*(1), 321-334. doi:10.1007/bf00694595

Kanazawa, S., & Kovar, J. L. (2004). Why beautiful people are more intelligent. *Intelligence*, *32*(3), 227-243. doi:10.1016/j.intell.2004.03.003

Kantarevic, J., & Mechoulan, S. (2006). Birth order, educational attainment, and earnings: An investigation using the PSID. *The Journal of Human Resources*, *4*, 755-777. doi:10.3368/jhr.XLI.4.755

Kelly, J. (2000). Rethinking the elementary science methods course: a case for content, pedagogy, and informal science education. *International Journal of Science Education, 22,* 755-777. doi:10.1080/095006900500044080

Kiefer, A., & Sekaquaptewa, D. (2007). Implicit stereotypes, gender identification, and math related outcomes: A prospective study of female college students. *Psychological Science, 18*, 13-18. doi:10.1111/j.1467-9280.2007.01841.x

King, M. M., Bergstrom, C. T., Correll, S. J., Jacquet, J., & West, J. D. (2017). Men set their own cites high: Gender and self-citation across fields and over time. *Socius*, *3*. doi:10.1177/2378023117738903

Klimstra, T. (2013). Adolescent personality development and identity formation. *Child Development Perspectives, 7*(2), 80-84. doi:10.1111/cdep.12017

Knight, M., & Cunningham, C. (2004, June). Draw an engineer test (DAET): Development of a tool to investigate students' ideas about engineers and engineering. In *ASEE Annual Conference and Exposition* (Vol. 2004). Washington DC: American Society for Engineering Education.

Kober, N. (2010). *Policy implications of trends for Asian American students.* Washington, DC: Center on Education Policy.

Koren, M. (2018). *One Wikipedia page is a metaphor for the Nobel Prize's record with women.* Retrieved from https://www.theatlantic.com/science/archive/2018/10/nobel prize-physics-donna-strickland-gerard-mourou-ashkin/571909

Kornhaber, R. C. & Schroeder, H. E. (1975). Importance of model similarity on extinction of avoidance behavior in children. *Journal of Consulting and Clinical Psychology*, *43*(5), 601-607. doi:10.1037//0022-006x.43.5.601

Kotte, D. (1992). *Gender differences in science achievement in 10 countries*. Switzerland: Peter Lang, Frankfurt.

Krapp, A., Hidi, S., & Renninger, K. A. (1992). Interest, learning, and development. In K. A. Renninger & S. Hidi (Eds.), *The role of interest in learning and development* (pp. 3-25). Hillsdale, NJ: Erlbaum.

Krapp, A., & Prenzel, M. (2011). Research on interest in science: Theories, methods, and findings. *International Journal of Science Education*, *33*(1), 27-50. doi:10.1080/09500693.2010.518645

Kunce, J. T., Bruch, M. A., & Thelen, M. H. (1974). Vicarious induction of academic achievement behavior in disadvantaged adults. *Journal of Counseling Psychology, 21*(6), 507-510. doi:10.1037/h0037307

Lagoke, B. A., Jegede, O. J., & Oyebanji, P. K. (1997). Towards an elimination of the gender gulf in science concept attainment through the use of environmental analogs. *International Journal of Science Education*, *19*(4), 365-380. doi:10.1080/0950069970190401

Langlois, J. H., Kalakanis, L., Rubenstein, A., Larsen, A., Hallam, M., & Smoot, M. (2000). Maxims or myths of beauty? A meta-analytic and theoretical review. *Psychological Bulletin, 126*, 390-423. doi:10.1037//0033-2909.126.3.390

Langlois, J. H., Ritter, J. M., Roggmann, L. A, & Vaughn, L. S. (1991). Facial diversity and infant preferences for attractive races. *Developmental Psychology*, *27*, 79-84. doi:10.1037/0012-1649.27.1.79

Langlois, J. H., & Roggman, L. A. (1990). Attractive faces are only average. *Psychological Science,* 1, 115-121. doi:10.1111/j.1467-9280.1990.tb00079.x

Langlois, J. H., Roggman, L. A., & Musselman, L. (1994). What is average and what is not average about attractive faces? *Psychological Science, 5*, 214-220. doi:10.1111/j.1467-9280.1994.tb00503.x

Larkin, J. C., & Pines, H. A. (1979). No fat persons need apply experimental studies of the overweight stereotype and hiring preference. *Work and Occupations*, *6*(3), 312-327. doi:10.1177/073088847900600303

Lau, S., & Roeser, R. W. (2002). Cognitive abilities and motivational processes in high school students' situational engagement and achievement in science. *Educational Assessment, 8*(2), 139-162. doi:10.1207/s15326977ea0802_04

Leaper, C., & Ayres, M. M. (2007). A meta-analytic review of gender variations in adults' language use: Talkativeness, affiliative speech, and assertive speech. *Personality and Social Psychology Review*, *11*(4), 328-363. doi:10.1177/1088868307302221

Lee, V. E., & Burkam, D. T. (1996). Gender differences in middle grade science achievement: Subject domain, ability level, and course emphasis. *Science Education*, *80*(6), 613-650. doi:10.1002/(sici)1098-237x(199611)80:6<613::aid-sce1>3.0.co;2-m

Leman, K. (2009). *The birth order book: Why you are the way you are*. Grand Rapids, MI: Revell.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Towards a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45,* 79-122. doi:10.1006/jvbe.1994.1027

Lent, R. W., Brown, S. D., Grover, M. R., & Nijjer, S. K. (1996). Cognitive assessment of the sources of mathematics self-efficacy: A thought-listing analysis. *Journal of Career Assessment*, *4*, 33-46. doi:10.1177/106907279600400102

Lent, R. W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. *Journal of Counseling Psychology*, *33*(3), 265-269. doi:10.1037/0022-0167.33.3.265

Lent, R. W., Brown, S. D., & Larkin, K. C. (1987). Comparison of three theoretically derived variables in predicting career and academic behavior: Self-efficacy, interest congruence, and consequence thinking. *Journal of Counseling Psychology*, *34*(3), 293-298. doi:10.1037/0022-0167.34.3.293

Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1991). Mathematics self-efficacy: Sources and relation to science-based career choice. *Journal of Counseling Psychology*, 38(4), 424-430. doi:10.1037//0022-0167.38.4.424

Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1993). Predicting mathematics-related choice and success behaviors: Test of an expanded social cognitive model. *Journal of Vocational Behavior*, *42*(2), 223-236. doi:10.1006/jvbe.1993.1016

Lent, R. W., Lopez, F. G., Brown, S. D., & Gore, P.A. (1996). Latent structure of the sources of mathematics self-efficacy. *Journal of Vocational Behavior*, *49*, 292-308. doi:10.1006/jvbe.1996.0045

Lerner, G. (1985). Comment on Lerner's "Sarah M. Grimké's Sisters of Charity." *Signs: Journal of Women in Culture and Society*, *10*(4), 811-815. doi:10.1086/494193

Lerner, R. M. (1982). Children and adolescents as producers of their own development. *Developmental Review*, *2*(4), 342-370. doi:10.1016/0273-2297(82)90018-1

Levine, J., & Wycokoff, J. (1991). Predicting persistence and success in baccalaureate engineering. *Education*, *111*(4), 461-468.

Lichtenberger, E., & George-Jackson, C. (2013). Predicting high school students' interest in majoring in a STEM field: Insight into high school students' postsecondary plans. *Journal of Career and Technical Education*, *28*(1), 19-38. doi:10.21061/jcte.v28i1.571

Lindberg, S., Hyde, J., Petersen, J., & Linn, M. (2010). New trends in gender and mathematics performance: A meta-analysis. *Psychological Bulletin*, *136*(6), 1123-1135. doi:10.1037/a0021276

Linnenbrink, E. A., & Pintrich, P. R. (2003). The role of self-efficacy beliefs in student engagement and learning in the classroom. *Reading & Writing Quarterly*, *19*(2), 119-137. doi:10.1080/10573560308223

Little, A. C., Buriss, R. P., Jones, B. C., & Roberts, S. C. (2007). Facial appearance affects voting decisions. *Evolution and Human Behavior, 28*, 18-27. doi:10.1016/j.evolhumbehav.2006.09.002

Little, D. M., & Roach, A. J. (1974). Videotape modeling of interest in nontraditionaloccupations for women. *Journal of Vocational Behavior*, *5*(1), 133-138. doi:10.1016/0001-8791(74)90014-1

Livingston, G. (2014, April 24). *Among Hispanics, immigrants more likely to be stay-at-home moms and to believe that's best for kids*. Retrieved from Pew Research Center website: http://www.pewresearch.org/fact-tank/2014/04/24/among-hispanics-immigrants-more-likely-to-be-stay-at-home-moms-and-to-believe-thats-best-for-kids/

Long, M., Boiarsky, G., & Thayer, G. (2001). Gender and racial counter-stereotypes in science education television: A content analysis. *Public Understanding of Science*, *10*(3), 255-269.

Lopez, F. G., & Lent, R. W. (1992). Sources of mathematic self-efficacy in high school students. *The Career Development Quarterly*, *41*, 3-12. doi:10.1002/j.2161-0045.1992.tb00350.x

Lubinski, D., & Humphreys, L. G. (1990). A broadly based analysis of mathematical giftedness. *Intelligence*, *14*(3), 327-355. doi:10.1016/0160-2896(90)90022-l

Luszczynska, A., & Schwarzer, R. (2005). Social cognitive theory. *Predicting health behaviour*, *2*, 127-169.

Luzzo, D. A., Hasper, P., Albert, K. A., Bibby, M. A., & Martinelli, E. A., Jr. (1999). Effects of self-efficacy-enhancing interventions on the math/science self-efficacy and career interests, goals, and actions of career undecided college students. *Journal of Counseling Psychology*, *46*(2), 233-243. doi:10.1037//0022-0167.46.2.233

MacCorquodale, P. (1984). *Self-image, science and math: Does the image of the "scientist" keep girls and minorities from pursuing science and math?* Retrieved from ERIC database. (ED253493)

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology*, *51*(1), 93-120. doi:10.1348/000712601162059

Maibach, E., & Flora, J. A. (1993). Symbolic modeling and cognitive rehearsal: Using video to promote AIDS prevention self-efficacy. *Communication Research*, *20*(4), 517-545. doi:10.1177/009365093020004002

Malcolm, L. E. (2010). Charting the pathways to STEM for Latina/o students: The role of community colleges. In E. R. Harper & C. B. Newman (Eds.), *Students of color in STEM: Engineering a new research agenda* (pp. 29-40). San Francisco, CA: Jossey Bass. doi.org/10.1002/ir.359

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education*, *95*(5), 877-907.

ManpowerGroup. (2015). *2015 Talent Shortage Survey*. New York, NY: Author.

Manz, C. C., & Sims, H. P., Jr. (1981). Vicarious learning: The influence of modeling on organizational behavior. *Academy of Management Review*, *6*(1), 105-113. doi:10.5465/amr.1981.4288021

Maple, S. A., & Stage, F. K. (1991). Influences on the choice of math/science major by gender and ethnicity. *American Educational Research Journal*, *28*(1), 37-60. doi:10.3102/00028312028001037

Matsui, T., Matsui, K., & Ohnishi, R. (1990). Mechanisms underlying math self-efficacy learning of college students. *Journal of Vocational Behavior*, *37*(2), 225-238. doi:10.1016/0001-8791(90)90042-z

McGinnis, J. R., & Pearsall, M. (1998). Teaching elementary science methods to women: A male professor's experience from two perspectives. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *35*(8), 919-949. doi:10.1002/(sici)1098-2736(199810)35:8<919::aid-tea7>3.0.co;2-x

McMillan, J. G., & May, M. J. (1979). A study of factors influencing attitudes towards science of junior high school students. *Journal of Research in Science Teaching*, *15*, 217-222. doi:10.1002/tea.3660160307

Meece, J. L., & Jones, M. G. (1996). Gender differences in motivation and strategy use in science: Are girls rote learners? *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *33*(4), 393-406. doi:10.1002/(sici)1098-2736(199604)33:4<393::aid-tea3>3.0.co;2-n

Meece, J. L., & Jones, G. (1996). Girls in mathematics and science: Constructivism as a feminist perspective. *The High School Journal*, *79*(3), 242-248.

Meichenbaum, D. H. (1971). Examination of model characteristics in reducing avoidance behavior. *Journal of Personality and Social Psychology*, *17*, 298-307. doi:10.1037/h0030593

Miller, P. H., Slawinski Blessing, J., & Schwartz, S. (2006). Gender differences in high- school students' views about science. *International Journal of Science Education*, *28*(4), 363-381. doi:10.1080/09500690500277664

Milner, D. I., Horan, J. J., & Tracey, T. J. (2014). Development and evaluation of STEM interest and self-efficacy tests. *Journal of Career Assessment*, *22*(4), 642-653. doi:10.1177/1069072713515427

Mobius, M. M., & Rosenblat, T. S. (2006). Why beauty matters. *The American Economic Review ,96*(1), 222-235. doi:10.1257/000282806776157515

Monin, B. (2003). The warm glow heuristic: When liking leads to familiarity. *Journal of Personality and Social Psychology*, *85*(6), 1035-1048. doi:10.1037/0022-3514.85.6.1035

Morrow, P. C. (1990). Physical attractiveness and selection decision making. *Journal of Management*, *16*(1), 45-60. doi:10.1177/014920639001600104

Mulac, A., Bradac, J. J., & Gibbons, P. (2001). Empirical support for the gender-as-culture hypothesis: An intercultural analysis of male/female language differences. *Human Communication Research*, *27*(1), 121-152. doi:10.1111/j.1468-2958.2001.tb00778.x

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology, 38*(1), 30-38. doi:10.1037//0022-0167.38.1.30

Murphy, K. R., Herr, B. M., Lockhart, M. C., & Maguire, E. (1986). Evaluating the performance of paper people. *Journal of Applied Psychology, 71*(4), 654-661. doi:10.1037/0021-9010.71.4.654

Mussweiler, T. (2003). Comparison processes in social judgment: mechanisms and consequences. *Psychological Review*, *110*(3), 472-489. doi:10.1037/0033-295x.110.3.472

Nabi, R. L., & Clark, S. (2008). Exploring the limits of social cognitive theory: Why negatively reinforced behaviors on TV may be modeled anyway. *Journal of Communication, 58,* 407-427. doi:10.1111/j.1460-2466.2008.00392.x

National Center for Education Statistics. (2017). *Digest of Education Statistics: List of 2017 table.* Retrieved from https://nces.ed.gov/programs/digest/2017menu_tables.asp

National Research Council. (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning.* Washington, DC: National Academy Press.

National Research Council. (2010). *Gender differences at critical transitions in the careers of science, engineering, and mathematics faculty*. Washington, DC: National Academies Press.

National Science Foundation. (2011). *Women, minorities, and persons with disabilities in science and engineering.* Arlington, VA: Author.

National Science Foundation, Division of Science Resources Statistics. (2008). *Science and engineering degrees: 1966–2006* (NSF 08-321). Arlington, VA: Author.

National Student Clearinghouse. (2017). *Science and engineering degree completion by gender.* Retrieved from https://nscresearchcenter.org/wp-content/uploads/SnapshotReport27r.pdf

Nauta, M. M., & Epperson, D. L. (2003). A longitudinal examination of the social-cognitive model applied to high school girls' choices of nontraditional college majors and aspirations. *Journal of Counseling Psychology*, *50*(4), 448-457. doi:10.1037/0022-0167.50.4.448

Nauta, M. M., Epperson, D. L., & Kahn, J. H. (1998). A multiple-groups analysis of predictors of higher level career aspirations among women in mathematics, science, and engineering majors. *Journal of Counseling Psychology, 45*(4), 483-496. doi:10.1037/0022-0167.45.4.483

Nauta, M. M., Kahn, J, H., Angell, J. W., & Cantarelli, E. A. (2002). Identifying the antecedent in the relation between career interests and self-efficacy: Is it one, the other, or both? *Journal of Counseling Psychology*, *49*, 290-301. doi:10.1037//0022-0167.49.3.290

Nenninger, P. (1992). Task Motivation: an interaction between cognitive and content-oriented dimensions in learning. In K. A. Renninger & S. Hidi (Eds.), *The role of interest in learning and development* (pp. 212-149). Hillsdale, NJ: Erlbaum.

Nisbett, R. E., & Wilson, T. D. (1977). The halo effect: Evidence for unconscious alteration of judgements. *Journal of Personality and Social Psychology*, *35*, 250-256. doi:10.1037//0022-3514.35.4.250

Nittrouer, C. L., Hebl, M. R., Ashburn-Nardo, L., Trump-Steele, R. C., Lane, D. M., & Valian, V. (2018). Gender disparities in colloquium speakers at top universities. *Proceedings of the National Academy of Sciences*, *115*(1), 104-108. doi:10.1073/pnas.1708414115

The Nobel Foundation. (2018). *Nobel Prize awarded women*. Retrieved October 13, 2018 from https://www.nobelprize.org/prizes/lists/nobel-prize-awarded-women-3/

O'Brien, K. M., Dukstein, R. D., Jackson, S. L., Tomlinson, M. J., & Kamatuka, N. A. (1999). Broadening career horizons for students in at- risk environments. *The Career Development Quarterly*, *47*(3), 215-229. doi:10.1002/j.2161-0045.1999.tb00732.x

Organisation for Economic Co-operation and Development. (2013). *PISA 2012 assessment and analytical framework: Mathematics, reading, science, problem solving and financial literacy.* Paris, France: Author. doi:10.1787/9789264190511-en

Ortiz, M., & Harwood, J. (2007). A social cognitive theory approach to the effects of mediated intergroup contact on intergroup attitudes. *Journal of Broadcasting & Electronic Media, 51,* 615-631. doi:10.1080/08838150701626487

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, *25*(9), 1049-1079. doi:10.1080/0950069032000032199

Pajares, F. (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. *Contemporary Educational Psychology, 21*, 325-344. doi:10.1006/ceps.1996.0025

Pajares, F. (2002). *Overview of social cognitive theory and of self-efficacy.* Retrieved from http://www.emory.edu/EDUCATION/mfp/eff.htm

Pajares, F. (2005). Gender differences in mathematics self-efficacy beliefs. A. M. Gallagher & J. C. Kaufman (Eds.), *Gender differences in mathematics: An integrative psychological approach* (pp. 294-315). New York, NY: Cambridge University Press.

Pajares, F., & Johnson, M. J. (1996). Self- efficacy beliefs and the writing performance of entering high school students. *Psychology in the Schools*, *33*(2), 163-175. doi:10.1002/(sici)1520-6807(199604)33:2<163::aid-pits10>3.0.co;2-c

Pajares, F., & Schunk, D. H. (2010). Self-beliefs and school success: Self-efficacy, self-concept, and school achievement. In R. Riding & S. Rayner (Eds), *Self-perception* (pp. 239-266). London, England: Ablex.

Patzer, G. L. (1985). *The physical attractiveness phenomena*. New York, NY: Plenum Press.

Pendry, L. F., & Macrae, C. N. (1994). Stereotypes and mental life: The case of the motivated but thwarted tactician. *Journal of Experimental Social Psychology*, *30*(4), 303-325. doi:10.1006/jesp.1994.1015

Pennebaker, J. W., Mehl, M. R., & Niederhoffer, K. G. (2003). Psychological aspects of natural language use: Our words, our selves. *Annual Review of Psychology*, *54*(1), 547-577. doi:10.1146/annurev.psych.54.101601.145041

Perrett, D. I., Burt, D. M., Penton-Voak, I. S., Lee, K. J., Rowland, D. A., & Edwards, R. (1999). Symmetry and human facial attractiveness. *Evolution and Human Behavior, 21*, 39-48. doi:10.1016/s1090-5138(99)00014-8

Perrett, D. I., May, K. A., & Yoshikawa, D. (1994). Facial shapes and judgments of female attractiveness, *Nature*, *17*, 239-242. doi:10.1038/368239a0

Perry, D. G., & Perry, L. C. (1975). Observational learning in children: Effects of sex of model and subject's sex role behavior. *Journal of Personality and Social Psychology, 31*(6), 1083-1088. doi:10.1037/h0076944

Pfann, G. A., Biddle, J. E., Hamermesh, D. S., & Bosman, C. M. (2000). Business success and businesses' beauty capital. *Economics Letters*, *67*(2), 201-207. doi:10.1016/s0165-1765(99)00255-4

Pietsch, J., Walker, R., & Chapman, E. (2003). The relationship among self-concept, self-efficacy, and performance in mathematics during secondary school. *Journal of Educational Psychology*, *95*(3), 589-603. doi:10.1037/0022-0663.95.3.589

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33-40. doi:10.1037//0022-0663.82.1.33

Plucker, J. A. (1996). Secondary science and mathematics teachers and gender equity: Attitudes and attempted interventions. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 33*(7), 737-751. doi:10.1002/(sici)1098-2736(199609)33:7<737::aid-tea3>3.0.co;2-o

Pollack, E. (2016). *Only woman in the room: Why science is still a boys club.* Boston, MA: Beacon.

Preckel, F., Goetz, T., Pekrun, R., & Kleine, M. (2008). Gender differences in gifted and average-ability students comparing girls' and boys' achievement, self-concept, interest, and motivation in mathematics. *Gifted Child Quarterly*, *52*(2), 146-159. doi:10.1177/0016986208315834

Rathi, A. (2017). *The Nobel Prize committee explains why women win so few prizes.* Retrieved from http://qz.com/1097888/the-nobel-prize-committee-explains-why-women-win-so-few-prizes/

Rhodes, G. (2006). The evolutionary psychology of facial beauty. *Annual Review of Psychology, 57,* 199-226. doi:10.1146/annurev.psych.57.102904.190208

Rhodes, G., Yoshikawa, S., Clark, A., Lee, K., McKay, R., & Akamatsu, S. (2001). Attractiveness of facial averageness and symmetry in non-Western cultures: In search of biologically based standards of beauty. *Perception, 30,* 611-625. doi:10.1068/p3123

Rodgers, J. L. (2001). What causes birth order–intelligence patterns? The admixture hypothesis, revived. *American Psychologist*, *56*(6-7), 505-510. doi:10.1037/0003-066X.56.6-7.505

Rosekrans, M. A. (1967). Imitation in children as a function of perceived similarity to a social mode and vicarious reinforcement. *Journal of Personality and Social Psychology, 7*(3), 307-315. doi:10.1037/h0025072

Rosen, S. (1968). *Plato's symposium*. South Bend, IN: St. Augustine's Press. doi:10.2307/2217850

Rosenbaum, M. E., & Tucker, I. F. (1962). The competence of the model and the learning of imitation and non-imitation. *Journal of Experimental Psychology, 63*(2), 183-190. doi:10.1037/h0042363

Rosenberg- Kima, R. B., Plant, E. A., Doerr, C. E., & Baylor, A. L. (2010). The influence of computer- based model's race and gender on female students' attitudes and beliefs towards engineering. *Journal of Engineering Education*, *99*(1), 35-44. doi:10.1002/j.2168-9830.2010.tb01040.x

Rosenthal, D. B. (1993). Images of scientists: A comparison of biology and liberal studies majors. *School Science and Mathematics*, *93*(4), 212-216. doi:10.1111/j.1949-8594.1993.tb12227.x

Rossi, A. S. (1965). Barriers to the career choice of engineering, medicine, or science among American women. In *Women and the scientific professions* (pp. 51-127). Cambridge, MA: MIT Press Cambridge.

Ryan, T. P., & Morgan, J. P. (2007). Modern experimental design. *Journal of Statistical Theory and Practice*, *1*(3-4), 501-506. doi:10.1080/15598608.2007.10411855

Sadker, M., Sadker, D., & Klein, S. (1991). The issue of gender in elementary and secondary education. *Review of Research in Education*, *17*, 269-334. doi:10.3102/0091732X017001269

Sahin, A., Ekmekci, A., & Waxman, H. C. (2017). The relationships among high school STEM learning experiences, expectations, and mathematics and science efficacy and the likelihood of majoring in STEM in college. *International Journal of Science Education*, *39*(11), 1549-1572. doi:10.1080/09500693.2017.1341067

Santos, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of Extension*, *37*(2), 1-5.

Sarsons, H. (2015). Gender differences in recognition for group work. *Harvard University*, *3*.

Saucerman, J., & Vasquez, K. (2014). Psychological barriers to STEM participation for women over the course of development. *Adultspan Journal*, *13*(1), 46-64. doi:10.1002/j.2161-0029.2014.00025.x

Sax, L. J. (1994). Retaining tomorrow's scientists: Exploring the factors that keep male and female college students interested in science careers. *Journal of Women and Minorities in Science and Engineering*, *1*(1). doi:10.1615/jwomenminorscieneng.v1.i1.40

Scantlebury, K., Baker, D., Sugi, A., Yoshida, A., & Uysal, S. (2007). Avoiding the issue of gender in Japanese science education. *International Journal of Science and Mathematics Education*, *5*(3), 415-438. doi:10.1007/s10763-006-9045-8

Schiefele, U. (2009). Situational and individual interest. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 197-222). Mahwah, NJ: Erlbaum.

Schiefele, U., Krapp, A., & Winteler, A. (1992). Interest as a predictor of academic achievement: A metaanalysis of research. In K. A. Renninger & S. Hidi (Eds.), *The role of interest in learning and development* (pp. 183-212). Hillsdale, NJ: Erlbaum.

Schunk, D. H. (1981). Modeling and attributional effects on children's achievement: A self-efficacy analysis. *Journal of Educational Psychology, 73*(1), 93-105. doi:10.1037/0022-0663.73.1.93

Schunk, D. H. (1983). Developing children's self-efficacy and skills: The roles of social comparative information and goal setting. *Contemporary Educational Psychology, 8,* 76-86. doi:10.1016/0361-476x(83)90036-x

Schunk, D. H. (1986). Vicarious influences on self-efficacy for cognitive skill learning. *Journal of Social and Clinical Psychology, 4,* 316-327. doi:10.1521/jscp.1986.4.3.316

Schunk, D. H. (1987). Peer models and children’s behavioral change. *Review of Educational Research, 57*, 149-174. doi:10.2307/1170234

Schunk, D. H. (1995). *Social origins of self-regulatory competence: The role of observational learning through peer modeling*. Retrieved from ERIC database. (ED381275)

Schunk, D. H. (2003). Self-efficacy for reading and writing: Influence of modeling, goal setting, and self-evaluation. *Reading & Writing Quarterly*, *19*(2), 159-172. doi:10.1080/10573560308219

Schunk, D. H. (2012). *Learning theories an educational perspective sixth edition*. New York, NY: Pearson.

Schunk, D. H., & Hanson, A. R. (1985). Peer models: Influence on children’s self-efficacy and achievement. *Journal of Educational Psychology, 77*, 313-322. doi:10.1037//0022-0663.77.3.313

Schunk, D. H., Hanson, A. R., & Cox, P. D. (1987). Peer model attributes and children's achievement behaviors. *Journal of Educational Psychology, 79,* 54-61. doi:10.1037/0022-0663.79.1.54

Schunk, D. H., & Pajares, F. (2002). The development of academic self-efficacy. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation: A volume in educational psychology series* (pp. 15-31). San Diego, CA: Academic Press.

Schunk, D. H., & Zimmerman, B. J. (2007). Influencing children's self-efficacy and self-regulation of reading and writing through modeling. *Reading & Writing Quarterly*, *23*(1), 7-25. doi:10.1080/10573560600837578

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology: An International Review, 57*, 1-29. doi:10.1111/j.1464-0597.2007.00325.x

Shahani, C., Dipboye, R., & Gehrien, T. (1993). Attractiveness bias in the interview: Exploring the boundaries of an effect. *Basic and Applied Social Psychology*, *14*, 317-328. doi:10.1207/s15324834basp1403_5

Shannon, M. L., & Stark, C. P. (2003). The influence of physical appearance on personnel selection. *Social Behavior and Personality: An International Journal*, *31*(6), 613-623. doi:10.2224/sbp.2003.31.6.613

Shapiro, D., Dundar, A., Huie, F., Wakhungu, P. K., Yuan, X., Nathan, A., & Hwang, Y. (2017, September). *Tracking transfer: Measures of effectiveness in helping community college students to complete bachelor's degrees* (Signature Report No. 13). Herndon, VA: National Student Clearinghouse Research Center.

Sieff, K. (2011, April 5). Achievement gap widening between Asian American students and everyone else. *The Washington Post*. Retrieved from http://blogs.cfed.org/cfed_news_clips/2011/04/achievement-gap-wideningbetwe.html

Sigall, H., & Ostrove, N. (1975). Beautiful but dangerous: Effects of offender attractiveness and nature of the crime on juridic judgement. *Journal of Personality and Social Psychology, 31*, 410-414. doi:10.1037/h0076472

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology*, *42*(1), 70-75. doi:10.1037/0012-1649.42.1.70

Simpson, R. D. (1987). Relating student feelings to achievement in science. In M. B. Rowe (Ed.), *What research says to the science teacher* (Vol. 1). Washington, D.C.: National Science Teachers Association.

Sjøberg, S., & Schreiner, C. (2005, December). How do learners in different cultures relate to science and technology? Results and perspectives from the project ROSE (the Relevance of Science Education). In *Asia-Pacific forum on science learning and teaching* (Vol. 6, No. 2, pp. 1-17). China: The Education University of Hong Kong, Department of Science and Environmental Studies.

Sonnert, G., & Holton, G. J. (1995). *Who succeeds in science?: The gender dimension*. New Brunswick, NJ: Rutgers University Press.

Spelke, E. (2005). Sex differences in intrinsic aptitude for mathematics and science? A critical review. *American Psychology, 60*, 950-958. doi:10.1037/0003-066x.60.9.950

Stahlberg, D., Braun, F., Irmen, L., & Sczesny, S. (2007). Representation of the sexes in language. In K. Fiedler (Ed.), *Social communication* (pp. 163-187). New York, NY: Psychology Press.

Stake, J. E., & Nickens, S. D. (2005). Adolescent girls' and boys' science peer relationships and perceptions of the possible self as scientist. *Sex Roles*, *52*(1-2), 1-11. doi:10.1007/s11199-005-1189-4

Steinke, J. (2005). Cultural representations of gender and science portrayals of female scientists and engineers in popular films. *Science Communication*, *27*(1), 27-63. doi:10.1177/1075547005278610

Steinke, J., Lapinski, M. K., Crocker, N., Zietsman-Thomas, A., Williams, Y., Evergreen, S. H., & Kuchibhotla, S. (2007). Assessing media influences on middle school–aged children's perceptions of women in science using the Draw-A-Scientist Test (DAST). *Science Communication*, *29*(1), 35-64. doi:10.1177/1075547007306508

Stout, J. G., & Dasgupta, N. (2011). When he doesn't mean you: Gender-exclusive language as ostracism. *Personality and Social Psychology Bulletin*, *37*(6), 757-769. doi:10.1177/0146167211406434

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology*, *100*(2), 255-300. doi:10.1037/a0021385

St. Rose, A. (2010). STEM major choice and the gender pay gap. *On Campus with Women*, *39*(1), 1.

Sugiyama, L. S. (2005). Physical attractiveness in adaptationist perspective. In D. M. Buss (Ed), *Evolutionary psychology handbook* (pp. 292-343). New York, NY: Wiley.

Symbaluk, D. G., Heth, C. D., Cameron, J., Pierce, W. D. (1997). Social modeling, monetary incentives, and pain endurance: The role of self-efficacy and pain perception. *Personality and Social Psychology Bulletin, 23*, 258-269. doi:10.1177/0146167297233005

Symons, D. (1995). Beauty is in the adaptation of the beholder. In P. R. Abramson & S. D. Pinkerson (Eds.), *Sexual nature, sexual culture* (pp. 80-118). IL: University of Chicago Press.

Thelen, M. H., Fry, R. A., Fehrenbach, P. A., & Frautschi, N. M. (1979). Therapeutic videotape and film modeling: A review. *Psychological Bulletin, 86*(4), 701-720. doi:10.1037/0033-2909.86.4.701

Thomas, J., & Williams, C. (2009). The history of specialized STEM schools and the formation and role of the NCSSSMST. *Roeper Review*, *32*(1), 17-24. doi:10.1080/02783190903386561

Thorndike, E. L. (1920). A constant error in psychological ratings. *Journal of Applied Psychology, 4*, 24-29. doi:10.1037/h0071663

Thornton, B. (1977). Effect of rape victim's attractiveness in a jury simulation. *Personality and Social Psychology Bulletin*, *3*(4), 666-669. doi:10.1177/014616727700300422

Trusty, J. (2002). Effects of high school course- taking and other variables on choice of science and mathematics college majors. *Journal of Counseling & Development*, *80*(4), 464-474. doi:10.1002/j.1556-6678.2002.tb00213.x

Tsapogas, J. (2004). *The role of community college in the education of recent science and engineering graduates.* Arlington, VA: National Science Foundation.

Tyson, W., Lee, R., Borman, K. M., & Hanson, M. A. (2007). Science, technology, engineering, and mathematics (STEM) pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk*, 12(3), 243-270. doi:10.1080/10824660701601266

United Nations Educational, Scientific and Cultural Organization Institute for Statistics. (2015). *Women in science*. Retrieved from http://www.uis.unesco.org/ScienceTechnology/Pages/women-in-science-leaky-pipeline-data-viz.aspx

Updegraff, K. A., McHale, S. M., & Crouter, A. C. (1996). Gender roles in marriage: What do they mean for girls' and boys' school achievement? *Journal of Youth and Adolescence, 25*(1), 73-88. doi:10.1007/bf01537381

Usher, E. L., & Pajares, F. (2006). Inviting confidence in school: Invitations as a critical source of the academic self-efficacy beliefs of entering middle school students. *Journal of Invitational Theory and Practice, 12*, 7-16.

Usher, E. L., & Pajares, F. (2008). Sources of self-efficacy in school: Critical review of the literature and future directions. *Review of Educational Research, 78*(4), 751-796. doi:10.3102/0034654308321456

Usher, E. L., & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology, 34*, 89-101. doi:10.1016/j.cedpsych.2008.09.002

U.S. Department of Education, National Center for Education Statistics. (2007). The condition of education 2007 (NCES 2007-064). Washington, DC: U.S. Government Printing Office.

Van Dinther, M., Dochy, F., & Segers, M. (2011). Factors affecting students' self-efficacy in higher education. *Educational Research Review, 6*(2), 95-108. doi:10.1016/j.edurev.2010.10.003

Van Leeuwen, M. L., & Neil Macrae, C. (2004). Is beautiful always good? Implicit benefits of facial attractiveness. *Social Cognition*, *22*(6), 637-649.

Vancouver, J. B., & Kendall, L. N. (2006). When self-efficacy negatively relates to motivation and performance in a learning context. *Journal of Applied Psychology, 91*, 1146-1153. doi:10.1037/0021-9010.91.5.1146

Vervecken, D., Hannover, B., & Wolter, I. (2013). Changing (S) expectations: How gender fair job descriptions impact children's perceptions and interest regarding traditionally male occupations. *Journal of Vocational Behavior*, *82*(3), 208-220. doi:10.1016/j.jvb.2013.01.008

Voss, J. F., & Schauble, L. (1992). Is interest educationally interesting? An interest-related model of learning. In K. A. Renninger & S. Hidi (Eds.), *The role of interest in learning and development* (pp. 101-120). Hillsdale, NJ: Erlbaum.

Wade, T. J., Loyden, J., Renninger, L., & Tobey, L. (2003). Wight halo effects: Individual differences in personality evaluations as functions of weight. *Personality and Individual Differences, 34*, 263-268. doi:10.1016/s0191-8869(02)00042-9

Watkins, L. M., & Johnston, L. (2000). Screening job applicants: The impact of physical attractiveness and application quality. *International Journal of Selection and Assessment*, *8*(2), 76-84. doi:10.1111/1468-2389.00135

Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta- analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching*, *32*(4), 387-398. doi:10.1002/tea.3660320407

Weisgram, E. S., & Bigler, R. S. (2006). The role of attitudes and interventions in high school girls; interest in computer science. *Journal of Women and Minorities in Science and Engineering*, *12*, 325-336. doi:10.1615/jwomenminorscieneng.v12.i4.40

Wendelken, D. J., & Inn, A. (1981). Nonperformance influences on performance evaluations: A laboratory phenomenon? *Journal of Applied Psychology, 66*(2), 149-158.doi:10.1037/0021-9010.66.2.149

Woehr, D. J., & Lance, C. E. (1991). Paper people versus direct observation: An empirical examination of laboratory methodologies. *Journal of Organizational Behavior (1986-1998), 12*(5), 387-397. doi:10.1002/job.4030120504

Wood, R., & Bandura, A. (1989). Social cognitive theory of organizational management. *Academy of Management Review*, *14*(3), 361-384. doi:10.5465/amr.1989.4279067

Yallapragada, R. R., Toma, A. G., & Roe, C. W. (2007). India: The future economic and knowledge superpower? *International Business & Economic Research Journal, 6*, 83-90. doi:10.19030/iber.v6i2.3346

Zeldin, A. L., Britner, S. L., & Pajares, F. (2008). A comparative study of the self- efficacy beliefs of successful men and women in mathematics, science, and technology careers. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *45*(9), 1036-1058. doi:10.1002/tea.20195

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal, 37*, 215-246. doi:10.3102/00028312037001215

Zhao, H., Seibert, S. E., & Hills, G. E. (2005). The mediating role of self-efficacy in the development of entrepreneurial intentions. *Journal of Applied Psychology, 90*(6), 1265-1272. doi:10.1037/0021-9010.90.6.1265

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal*, *29*(3), 663-676. doi:10.2307/1163261

Zimmerman, B. J., & Ringle, J. (1981). Effects of model persistence and statements of confidence on children's self-efficacy and problem solving. *Journal of Educational Psychology, 73*(4), 485-493. doi:10.1037/0022-0663.73.4.485

Zohar, A., & Bronshtein, B. (2005). Physics teachers' knowledge and beliefs regarding girls' low participation rates in advanced physics classes. *International Journal of Science Education*, *27*(1), 61-77. doi:10.1080/0950069032000138798

Zohar, A., & Sela, D. (2003). Her physics, his physics: Gender issues in Israeli advanced placement physics classes. *International Journal of Science Education*, *25*(2), 245-268. doi:10.1080/09500690210126766

Appendices

APPENDIX A

Examples of Profile Images

All of the the profile images were displayed in exactly the same size, showing only the head and shoulder of the model. No one image was bigger or more pronounced than another.

APPENDIX A (continued)

APPENDIX B

Profile Mockups

University X:

DNA gel electrophoresis lab

Picture of attractive female

Human Interest

Masculine language

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

How our work helps people:

One thing that DNA gel electrophoresis allows us to do is help identify people with potentially threatening diseases. By taking a DNA sample and closely examining it, we can tell is a person has a predisposition for a harmful health condition. This type of genetic screening can be done on children and help keep them from getting ill in the future. For example, our lab can do genetic screening for many types of cancers. If people get tested early, we can warn them in advance of any impending problems. As a result, people can get early screenings and possibly avoid this terrible disease. DNA gel electrophoresis helps have the lives of many adults and children.

What kind of people are we looking for in our lab:

We are looking for an aggressive individual who is independent and results oriented. A logical thinker who has a clear sense of how to accomplish an objective. This lab is looking for a decisive and determined colleague who is assertive and enjoys taking leadership roles.

APPENDIX B (continued)

University X:

DNA gel electrophoresis lab

Picture of average female

Human Interest

Masculine language

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge

APPENDIX B (continued)

in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

How our work helps people:

One thing that DNA gel electrophoresis allows us to do is help identify people with potentially threatening diseases. By taking a DNA sample and closely examining it, we can tell is a person has a predisposition for a harmful health condition. This type of genetic screening can be done on children and help keep them from getting ill in the future. For example, our lab can do genetic screening for many types of cancers. If people get tested early, we can warn them in advance of any impending problems. As a result, people can get early screenings and possibly avoid this terrible disease. DNA gel electrophoresis helps have the lives of many adults and children.

What kind of people are we looking for in our lab:

We are looking for an aggressive individual who is independent and results-oriented. A logical thinker who has a clear sense of how to accomplish an objective. This lab is looking for a decisive and determined colleague who is assertive and enjoys taking leadership roles.

APPENDIX B (continued)

University X:

DNA gel electrophoresis lab

Picture of attractive male

Human Interest

Masculine Language

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge

APPENDIX B (continued)

in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

How our work helps people:

One thing that DNA gel electrophoresis allows us to do is help identify people with potentially threatening diseases. By taking a DNA sample and closely examining it, we can tell is a person has a predisposition for a harmful health condition. This type of genetic screening can be done on children and help keep them from getting ill in the future. For example, our lab can do genetic screening for many types of cancers. If people get tested early, we can warn them in advance of any impending problems. As a result, people can get early screenings and possibly avoid this terrible disease. DNA gel electrophoresis helps have the lives of many adults and children.

What kind of people are we looking for in our lab:

We are looking for an aggressive individual who is independent and results oriented. A logical thinker who has a clear sense of how to accomplish an objective. This lab is looking for a decisive and determined colleague who is assertive and enjoys taking leadership roles.

APPENDIX B (continued)

University X:

DNA gel electrophoresis lab

Picture of average looking male

Human Interest

Masculine language

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

How our work helps people:

One thing that DNA gel electrophoresis allows us to do is help identify people with potentially threatening diseases. By taking a DNA sample and closely examining it, we can tell is a person has a predisposition for a harmful health condition. This type of genetic screening can be done on children and help keep them from getting ill in the future. For example, our lab can do genetic screening for many types of cancers. If people get tested early, we can warn them in advance of any impending problems. As a result, people can get early screenings and possibly avoid this terrible disease. DNA gel electrophoresis helps have the lives of many adults and children.

What kind of people are we looking for in our lab:

We are looking for an aggressive individual who is independent and results oriented. A logical thinker who has a clear sense of how to accomplish an objective. This lab is looking for a decisive and determined colleague who is assertive and enjoys taking leadership roles.

APPENDIX B (continued)

Attractive female

Human Interest

Female Gendered Language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

How our work helps people:

One thing that DNA gel electrophoresis allows us to do is help identify people with potentially threatening diseases. By taking a DNA sample and closely examining it, we can tell is a person has a predisposition for a harmful health condition. This type of genetic screening can be done on children and help keep them from getting ill in the future. For example, our lab can do genetic screening for many types of cancers. If people get tested early, we can warn them in advance of any impending problems. As a result, people can get early screenings and possibly avoid this terrible disease. DNA gel electrophoresis helps have the lives of many adults and children.

What kind of people are we looking for in our lab:

We are looking for a compassionate individual who is empathetic and results kind. A committed employee who is honest and nurturing. This lab is looking for a dependable and warm colleague who is considerate and enjoys working together with others.

APPENDIX B (continued)

average looking female Human Interest Female Gendered Language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge

APPENDIX B (continued)

in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

How our work helps people:

One thing that DNA gel electrophoresis allows us to do is help identify people with potentially threatening diseases. By taking a DNA sample and closely examining it, we can tell is a person has a predisposition for a harmful health condition. This type of genetic screening can be done on children and help keep them from getting ill in the future. For example, our lab can do genetic screening for many types of cancers. If people get tested early, we can warn them in advance of any impending problems. As a result, people can get early screenings and possibly avoid this terrible disease. DNA gel electrophoresis helps have the lives of many adults and children.

What kind of people are we looking for in our lab:

We are looking for a compassionate individual who is empathetic and results kind. A committed employee who is honest and nurturing. This lab is looking for a dependable and warm colleague who is considerate and enjoys working together with others.

APPENDIX B (continued)

Attractive male Human Interest Female Gendered Language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

How our work helps people:

One thing that DNA gel electrophoresis allows us to do is help identify people with potentially threatening diseases. By taking a DNA sample and closely examining it, we can tell is a person has a predisposition for a harmful health condition. This type of genetic screening can be done on children and help keep them from getting ill in the future. For example, our lab can do genetic screening for many types of cancers. If people get tested early, we can warn them in advance of any impending problems. As a result, people can get early screenings and possibly avoid this terrible disease. DNA gel electrophoresis helps have the lives of many adults and children.

What kind of people are we looking for in our lab:

We are looking for a compassionate individual who is empathetic and results kind. A committed employee who is honest and nurturing. This lab is looking for a dependable and warm colleague who is considerate and enjoys working together with others.

APPENDIX B (continued)

Average looking male
Human Interest
Female Gendered Language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

How our work helps people:

One thing that DNA gel electrophoresis allows us to do is help identify people with potentially threatening diseases. By taking a DNA sample and closely examining it, we can tell is a person has a predisposition for a harmful health condition. This type of genetic screening can be done on children and help keep them from getting ill in the future. For example, our lab can do genetic screening for many types of cancers. If people get tested early, we can warn them in advance of any impending problems. As a result, people can get early screenings and possibly avoid this terrible disease. DNA gel electrophoresis helps have the lives of many adults and children.

What kind of people are we looking for in our lab:

We are looking for a compassionate individual who is empathetic and results kind. A committed employee who is honest and nurturing. This lab is looking for a dependable and warm colleague who is considerate and enjoys working together with others.

APPENDIX B (continued)

Attractive female

No human interest

Female gendered language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge

APPENDIX B (continued)

in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

What kind of people are we looking for in our lab:

We are looking for a compassionate individual who is empathetic and results kind. A committed employee who is honest and nurturing. This lab is looking for a dependable and warm colleague who is considerate and enjoys working together with others.

APPENDIX B (continued)

average looking female

No human interest

Female gendered language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

What kind of people are we looking for in our lab:

We are looking for a compassionate individual who is empathetic and results kind. A committed employee who is honest and nurturing. This lab is looking for a dependable and warm colleague who is considerate and enjoys working together with others.

APPENDIX B (continued)

Attractive male

No human interest

Female gendered language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

What kind of people are we looking for in our lab:

We are looking for a compassionate individual who is empathetic and results kind. A committed employee who is honest and nurturing. This lab is looking for a dependable and warm colleague who is considerate and enjoys working together with others.

APPENDIX B (continued)

average looking male

No human interest

Female gendered language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

What kind of people are we looking for in our lab:

We are looking for a compassionate individual who is empathetic and results kind. A committed employee who is honest and nurturing. This lab is looking for a dependable and warm colleague who is considerate and enjoys working together with others.

APPENDIX B (continued)

Attractive female

No human interest

masculine gendered language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

What kind of people are we looking for in our lab:

We are looking for an aggressive individual who is independent and results oriented. A logical thinker who has a clear sense of how to accomplish an objective. This lab is looking for a decisive and determined colleague who is assertive and enjoys taking leadership roles.

APPENDIX B (continued)

average looking female

No human interest

masculine gendered language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

What kind of people are we looking for in our lab:

We are looking for an aggressive individual who is independent and results oriented. A logical thinker who has a clear sense of how to accomplish an objective. This lab is looking for a decisive and determined colleague who is assertive and enjoys taking leadership roles.

APPENDIX B (continued)

Attractive male

No human interest

masculine gendered language

University X:

DNA gel electrophoresis lab

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

What kind of people are we looking for in our lab:

We are looking for an aggressive individual who is independent and results oriented. A logical thinker who has a clear sense of how to accomplish an objective. This lab is looking for a decisive and determined colleague who is assertive and enjoys taking leadership roles.

APPENDIX B (continued)

University X:

DNA gel electrophoresis lab

average looking male

No human interest

masculine gendered language

What we do:

Here at the University X my work is on DNA gel electrophoresis. This is a relatively common lab technique that separates DNA and RNA based on their size and charge. Estimating DNA and RNA size allows for Mapping of DNA strands and is used in the fields of molecular biology, genetics, microbiology, and bio chemistry.

How the process works:

Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through a matrix of agarose or other substances. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily

APPENDIX B (continued)

through the pores of the gel. This phenomenon is called sieving. Proteins are separated by charge in agarose because the pores of the gel are too large to sieve proteins. Gel electrophoresis can also be used for separation of nanoparticles.

What kind of people are we looking for in our lab:

We are looking for an aggressive individual who is independent and results oriented. A logical thinker who has a clear sense of how to accomplish an objective. This lab is looking for a decisive and determined colleague who is assertive and enjoys taking leadership roles.

APPENDIX C

Career Interest in Science, Technology, Engineering, and Mathematics

For the following survey questions, please recall the scientist profile you viewed at the start of this session.

You will now see a series of STEM related tasks. For each item please identify how interested you would be in performing the described tasks.

Use this scale to indicate your level of interest-Strongly dislike (1), Dislike (2), Neutral (3), Like (4), Strongly like (5). Mark the response that best reflects your interest.

To what degree do you think you would like to…	Strongly dislike		Neutral		Strongly like
Redesign an engine to improve fuel efficiency	1	2	3	4	5
Measure the speed of electrons	1	2	3	4	5
Maintain the main generator in a power plant	1	2	3	4	5
Analyze problems with aircraft design	1	2	3	4	5
Study the nature of quantum physics	1	2	3	4	5
Study the laws of gravity	1	2	3	4	5
Apply mathematical techniques to practical problems	1	2	3	4	5
Create a computer database	1	2	3	4	5

APPENDIX C (continued)

STEM CAREER SELF-EFFICACY

For the following survey questions, please recall the scientist profile you viewed at the start of this session.

You will now see a series of STEM related tasks. For each item please identify how confident you would be in performing the described tasks.

Use this scale to indicate your level of confidence –*Not confident (1), Slightly confident (2), Confident(3), Very confident (4), Extremely confident (5).* Mark the response that best reflects your interest.

Given the proper education and training, to what degree are you confident that you could…	Not confident		Somewhat confident		Extremely Confidant
Design a diagnostic routine for a power plant	1	2	3	4	5
Modify an equipment design to reduce sound level	1	2	3	4	5
Measure the speed of electrons	1	2	3	4	5
Improve the efficiency of an assembly process	1	2	3	4	5
Test a new cooling system	1	2	3	4	5
Improve computer network efficiency	1	2	3	4	5
Calculate the probability of winning a contest	1	2	3	4	5
Design a technology system for distance learning	1	2	3	4	5

APPENDIX C (continued)

STEM Occupational Interest

For the following survey questions, please recall the scientist profile you viewed at the start of this session.

You will now see a series of STEM related tasks. For each item please identify how interested you would be in performing the described tasks.

Use this scale to indicate your level of interest-*Strongly dislike (1), Dislike (2), Neutral (3), Like (4), Strongly like (5).* Mark the response that best reflects your interest.

To what degree do you think you would like to work as a…	Strongly dislike		Neutral		Strongly like
Chemical engineer: design chemical plant equipment and devise processes for manufacturing chemicals and products, such as gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp, by applying principles and technology of chemistry, physics, and engineering	1	2	3	4	5
Physicist: Conduct research into phases of physical phenomena, develop theories and laws on the basis of observation and experiments, and devise methods to apply laws and other fields	1	2	3	4	5
Electrical Engineer: Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, and systems for commercial, industrial, military, or scientific use.	1	2	3	4	5
Computer Scientist: Conduct research into fundamental computer and information science as theorists, designers, or inventors	1	2	3	4	5
Statistician: Engage in the development of mathematical theory or apply statistical theory and methods to collect, organize, interpret, and summarize numerical data to provide usable information.	1	2	3	4	5
Microbiologist: Investigate the growth, structure, development, and other characteristics of microscopic organisms, such as bacteria, algae, or fungi assignment	1	2	3	4	5

APPENDIX C (continued)

STEM OCCUPATIONAL SELF-EFFICACY

For the following survey questions, please recall the scientist profile you viewed at the start of this session. You will now see a series of STEM related tasks. For each item please identify how confident you would be in performing the described tasks. Use this scale to indicate your level of confidence –*Not confident (1), Slightly confident (2), Confident(3), Very confident (4), Extremely confident (5).* Mark the response that best reflects your interest.

<u>Given the proper education and training</u>, to what degree are you confident that you could be a/an…	Not confide nt		Somewhat confident		Extremely Confidant
Electrical Engineer: Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, and systems for commercial, industrial, military, or scientific use.	1	2	3	4	5
Atmospheric or space scientist: Investigate atmospheric phenomena and interpret meteorological data gathered by surface and air stations, satellites, and radar to prepare reports and forecasts for public and other uses	1	2	3	4	5
Biochemist/Biophysicist: Study the chemical composition and physical principles of living cells and organisms, their electrical and mechanical energy, and related phenomena.	1	2	3	4	5
Chemical engineer: design chemical plant equipment and devise processes for manufacturing chemicals and products, such as gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp, by applying principles and technology of chemistry, physics, and engineering.	1	2	3	4	5
Physicist: Conduct research into phases of physical phenomena, develop theories and laws on the basis of observation and experiments, and devise methods to apply laws and other fields.	1	2	3	4	5
Operations Research analyst: Formulate and apply mathematical modeling and other optimizing methods using a computer to develop and interpret information that assists management with decision making, policy, formulation, or other managerial functions.	1	2	3	4	5

APPENDIX C (continued)

Demographic Information

1. What is your gender?

a. Male

b. Female

2. In what class are you currently taking this survey?

a. English II-College Prep

b. English II-Honors

c. English III-College Prep

d. English III-Honors

3. How would you describe yourself?

a. American Indian or Alaska Native

b. Hawaiian or Other Pacific Islander

c. Asian or Asian American

d. Black or African American

e. Hispanic or Latino

f.Non-Hispanic White

g. None of these options are representative

APPENDIX C (continued)

4. Which campus do you attend?

a. East

b. West

5. Where are you in the birth order in relation to your other siblings?

a. I am the oldest

b. I am somewhere in the middle

c. I am the youngest

d. I am an only child

6. Consider your father's profession. Would you say that he works in a field that is in any way related to science, technology, engineering, or math? This DOES NOT include the field of medicine

a. Yes

b. No

c. I prefer not to answer

7. Consider your father's profession. Would you say that he works in a field that is in any way related to science, technology, engineering, or math? This includes the field of medicine

a. Yes

b. No

c. I prefer not to answer

APPENDIX C (continued)

8. Consider your mother's profession. Would you say that she works in a field that is in any way related to science, technology, engineering, or math? This DOES NOT include the field of medicine

a. Yes

b. No

c. I prefer not to answer

9. Consider your mother's profession. Would you say that she works in a field that is in any way related to science, technology, engineering, or math? This includes the field of medicine

a. Yes

b. No

c. I prefer not to answer

APPENDIX C (continued)

Think back to all the classes you have taken or plan on taking to answer the following questions

Please put a check by all the math classes which YOU HAVE ALREADY TAKEN as well as the grade that you received in the course:

Curriculum Maps

ELL 161/162 Sheltered Transitional Algebra I
ELL 181/182 Sheltered Algebra I
ELL 191/192 Sheltered Geometry
MAT 0119/0129 Principles of Algebra and Geometry (CC)
MAT 101/102 Algebra I Block
MAT 1019/1029 Algebra IA (CC)
MAT 1039/1049 Algebra IB (CC)
MAT 111/112 Algebra I
MAT 191/192 Algebra I Honors
MAT 201/202 Geometry Basic
MAT 2019/2029 Geometry Basic (CC)
MAT 221/222 Geometry
MAT 231/232 Geometry Honors
MAT 251/252 Freshman Algebra II Honors

Curriculum Maps

ELL 291/292 Sheltered Algebra II
MAT 241/242 Algebra II Honors
MAT 311/312 Algebra II
MAT 331/332 Statistics and Applied Math
MAT 341/342 PreCalculus Honors
MAT 351/352 Intermediate Algebra II
MAT 361/362 PreCalculus
MAT 371/372 AP Statistics
MAT 441/442 AP Calculus

APPENDIX C (continued)

Please put a check by all the math classes which YOU PLAN ON TAKING:

Curriculum Maps

- ELL 291/292 Sheltered Algebra II
- MAT 241/242 Algebra II Honors
- MAT 311/312 Algebra II
- MAT 331/332 Statistics and Applied Math
- MAT 341/342 PreCalculus Honors
- MAT 351/352 Intermediate Algebra II
- MAT 361/362 PreCalculus
- MAT 371/372 AP Statistics
- MAT 441/442 AP Calculus

Please put a check by all the science classes which YOU HAVE ALREADY TAKEN as well as the grade that you received in the course:

Curriculum Maps

- ELL 261/262 Sheltered Physical Science
- ELL 281/282 Sheltered Biology
- ELL 311/312 Sheltered General Science
- SCI 101/102 Physical Science Academy
- SCI 121/122 Biology Hn
- SCI 131/132 Physical Science
- SCI 1319/1329 Physical Science (CC)
- SCI 201/202 Biology Academy
- SCI 251/252 Biology
- SCI 2519/2529 Biology (CC)

APPENDIX C (continued)

Curriculum Maps

SCI 221/222 Chemistry Honors
SCI 311/312 Chemistry
SCI 321/322 Physics
SCI 331/332 Physics Hn
SCI 341/342 AP Biology
SCI 350 Medical Careers
SCI 360 Earth Science
SCI 370 Chemistry of Foods
SCI 421/422 AP Physics I
SCI 431/432 AP Chemistry
SCI 471/472 Anatomy and Physiology

Please put a check by all the science classes which YOU PLAN ON TAKING:

Curriculum Maps

SCI 221/222 Chemistry Honors
SCI 311/312 Chemistry
SCI 321/322 Physics
SCI 331/332 Physics Hn
SCI 341/342 AP Biology
SCI 350 Medical Careers
SCI 360 Earth Science
SCI 370 Chemistry of Foods
SCI 421/422 AP Physics I
SCI 431/432 AP Chemistry
SCI 471/472 Anatomy and Physiology

APPENDIX C (continued)

10. After graduating high school, I plan on attending a two year college with an intent to transfer to a four year institution
    a. Yes
    b. No
    c. I am not sure what I will do
    d. I am not sure about the difference

11. After graduating high school I plan on attending a two year college and **NOT** transferring to a 4 year institution.
    a. Yes
    b. Not
    c. I am not sure what I will do
    d. I am not sure about the difference

12. After graduating high school I plan on attending a four year college/university.
    a. Yes
    b. No
    c. I am not sure what I will do

APPENDIX D

Experimental Procedure

Two weeks prior to intervention
Students were introduced to the topics; voluntary nature of participation was explained; questioned were addressed
Day of intervention
Students logged into their computers and followed the link provided by their teacher Students consented to participation on the first page of the website Students read the profile and examined the picture Students complete a profile verification questioner Students assess the attractiveness of the model Students complete the self-efficacy and interest survey followed by the demographics
Post intervention
There were no follow up activities

VITA

GENA KHODOS-BATTLE

994 Princeton Ave, Highland Park, IL 60035 • 312.504.2842 • gkhodos@gmail.com

Education

Doctor of Philosophy University of Illinois-Chicago Chicago, IL
Educational Psychology
Dissertation: "Women in STEM: Examining the Perennial Gender Gap"
December, 2018

Master of Teaching National Louis University Chicago, IL
Department of Education
May, 2004

Bachelor of Arts University of Iowa Iowa City, IA
English
May, 2003

Professional License, Endorsements, and Training

Illinois Professional Educator's License #1928743, 2004-2023
Reading Specialist Kindergarten through Grade 12 IL Endorsement
English Senior HS - Grade 9 through Grade 12 IL Endorsement

Teaching Experience

2008-Present **Leyden High School District 212** Franklin Park, IL
English teacher

• Instruct a variety of courses and levels in a diverse, low-to-middle income community with a significant ELL and low income population.

2009-20014 **University of Illinois-Chicago** Chicago, IL
Adjunct Faculty

• Instructed graduate and undergraduate psychology courses focusing on the psychological developments and trajectories of children and young adults

2007-2009 **Hinsdale High School District 86** Darien, IL
Reading Specialist

•Developed and taught a pilot course designed to increase reading comprehension in the sciences

2004-2007 **Wheeling High School, District 212** Wheeling, IL
English Teacher

• Instructed 9th and 10th grade core literature and writing courses on college preparatory and Advanced Placement levels.

VITA (continued)

2008-2009 **Harper College** Palatine, IL

Adjunct Faculty

• Instructed two classes of a graduate level course focusing on new literacies and best practice

Program Development

2008-Present **Leyden High School District 212** Franklin Park, IL

Teacher, English

- Participated in designing course scope and sequence with assessments aligned to the Common Core Standards.
- Participated in mapping the English department curriculum using Performance Plus software.
- Participated in the development of online course modules in preparation for a one-to-one computer environment.
- Participated in the development of a new Literacy Department and advocated its creation. .
- Ongoing member of a team of instructors in the regular review of student achievement data to make curricular adjustments.

1995-2005 **Hinsdale High School District 86** Darien, IL

Reading Specialist, Science

- Developed and taught a pilot course designed to increase reading comprehension in the sciences
- Instructed a GeoPhysics Academic Reading course with a focus on comprehension and vocabulary
- Collaborated with colleagues on piloting additional reading focused science courses
- Led staff development on integration of direct vocabulary instruction and reading strategies
- Coached staff on integration of high level literacy skills into an existing curriculum
- Assessed the quality of all text materials to be adopted by the department
- Designed assessments to measure longitudinal student growth

.

Presentations

•Brown, S.W., Lawless, K.A., Boyer, M., Yukhymenko, M.., Mullin, G., Brodowinska Bruscianelli, K., Khodos, G., & Lynn, L.J., (2012, May). The Impact of Simulation Games on Science Knowledge: The GlobalEd 2 Project. Poster presented at the Association for Psychology Science: Annual Convention, Chicago, IL.

•Brown, S., Lawless, K., Boyer, M., Yukhymenko, M., Mullin, G., Brodowinska, K., Khodos, G., Powell, N., & Lynn, L., (2012, Feb). Increasing technology and writing self-efficacy through a PBL simulation: GlobalEd 2. Paper presented at the Eastern Educational Research Association (EERA) Annual Conference, Hilton Head, SC.

VITA (continued)

- Khodos, G., Manderino, M., & Lawless, K. (2011, April). *Social Self-Efficacy in Virtual Versus Face-to-Face Environments.* Poster presented at the annual meeting of the American Educational Research Association, New Orleans, LA

- Khodos, G., Manderino, M., Lawless, K., Heppeler, J. (2013, April). *Implications of Computer-Mediated Instruction: A Comparison of Virtual and Face-to-Face Self-Efficacy*. Poster presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

- Khodos, G., Manderino, M., & Lawless, K. (2012, April). *Social Self-Efficacy in Virtual Versus Face-to-Face Environments.* Poster presented at the annual meeting of the American Educational Research Association, Vancouver, BC.

- Lawless, K.A., Brown, S.W., Brodowinska, K., Lynn, L., Khodos, G., Mullin, G.P., Yukhymenko,M., & Boyer, M.A. (2012, June). Distributed learning environments: Cooperative/collaborative learning. Paper presented at EdMedia 2012, Denver, CO.

Publications

- Brown, S.W., Boyer, M.A., Lawless, K.A., Yukhymenko, M.A., Mullin, G.P., Gervais, L.L., Lynn, L., Brodowinska, K., & Khodos, G. (2014, Jan.). The impact of an international simulation game on students' academic self-efficacy and social perspective taking. Paper presented at the 2014 Hawaii International Conference on Education, Jan. 5, 2014, Honolulu, HI

- Brown, S. W., Lawless, K. A., Boyer, M. A., Mullin, G. P., Yukhymenko, M., Cutter, A.Brodowinska Bruscianelli, Powell, N., Fernada Enriquez, M., Rice, J. & Khodos, G., (2011, November). Impacting middle school students' science knowledge with problem-based learning simulations. In D. Sampson, J. M. Spector, D. Ifenthaler and P. Isaias (Eds.) Proceedings of The IADIS International Conference Cognition and Exploratory Learning in Digital Age (CELDA), p. 181-187. Rio de Janeiro, Brazil: International Association for Development of the Information Society.

- Lawless, K. A., Brown, S. W., Boyer, M. A., Brodowinska, K., Lynn, L., Khodos, G., Yukhymenko, M., Mullin, G. P., Lee, L. (2013). The GlobalEd 2 Game: Developing scientific literacy skills through interdisciplinary, technology-based simulations. In Psychology of Gaming, Y. Baek (ed.). Nova Publishing.

- Lawless, K. A., Brown, S. W., Boyer, M. A., Brodowinska, K., Mullin, G. P., Yukhymenko, M., Khodos, G., Lynn, L., Cutter, A., Powell, N. & Fernada Enriquez, M. (2011). Expanding the science and writing curricular space: The GlobalEd2 Project. In D. Sampson, J. M. Spector, D. Ifenthaler and P. Isaias (Eds.) Proceedings of The IADIS International Conference Cognition and Exploratory Learning in Digital Age (CELDA), p. 154-160. Rio de Janeiro, Brazil: International Association for Development of the Information Society.

- Lawless, K.A., Brown, S.W., Boyer, M.A., Brodowinska, K., O'Brien, D., Khodos, G., Cutter, A.B., Fernada Enriquez, M., Mullin, G., Powell, N. & Williams, G. (2010). GlobalEd 2: Learning and applying science outside of the laboratory through interdisciplinary, technology-based simulations. In T. Bastiaens et al. (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2010* (pp. 1939-1943). Chesapeake, VA: AACE. Retrieved from www.editlib.org/p/35838.

VITA (continued)

- Lawless, K., Brown, S., Boyer, M., Brodowinska, K., O'Brien, D., Khodos, G., ... & Williams, G. (2010, October). GlobalEd 2: Learning and Applying Science Outside of the Laboratory through Interdisciplinary, Technology-based Simulations. In E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (pp. 1939-1943). Association for the Advancement of Computing in Education (AACE).

Professional Organizations

American Education Research Association
National Council of Teachers of English