Growth Mindset Training to Increase Women's Self-Efficacy in Science and Engineering: A Randomized-Controlled Trial

by

Natalie Shay Fabert

A Dissertation Proposal Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved June 2014 by the
Graduate Supervisory Committee:

Bianca Bernstein, Chair
Jennifer Bekki
Mary Dawes
Richard Kinnier

ARIZONA STATE UNIVERSITY

August 2014

ABSTRACT

Undeclared undergraduates participated in an experimental study designed to explore the impact of an Internet-delivered "growth mindset" training on indicators of women's engagement in science, engineering, technology, and mathematics ("STEM") disciplines. This intervention was hypothesized to increase STEM self-efficacy and intentions to pursue STEM by strengthening beliefs in intelligence as malleable ("IQ attitude") and discrediting gender-math stereotypes (strengthening "stereotype disbelief"). Hypothesized relationships between these outcome variables were specified in a path model. The intervention was also hypothesized to bolster academic achievement. Participants consisted of 298 women and 191 men, the majority of whom were self-identified as White (62%) and 18 years old (85%) at the time of the study. Comparison group participants received training on persuasive writing styles and control group participants received no training. Participants were randomly assigned to treatment, comparison, or control groups. At posttest, treatment group scores on measures of IQ attitude, stereotype disbelief, and academic achievement were highest; the effects of group condition on these three outcomes were statistically significant as assessed by analysis of variance. Results of pairwise comparisons indicated that treatment group IQ attitude scores were significantly higher than the average IQ attitude scores of both comparison and control groups. Treatment group scores on stereotype disbelief were significantly higher than those of the comparison group but not those of the control group. GPAs of treatment group participants were significantly higher than those of control group participants but not those of comparison group participants. The effects of group condition on STEM self-efficacy or intentions to pursue STEM were not significant. Results of path analysis indicated that the hypothesized model of the relationships between variables fit to an acceptable degree. However, a model with gender-specific paths from IQ attitude and stereotype disbelief to STEM self-efficacy was found to be superior to the hypothesized model. IQ attitude and stereotype disbelief were positively related; IQ attitude was positively related to men's STEM self-efficacy; stereotype disbelief was positively related to women's STEM self-efficacy, and STEM self-efficacy was positively related to intentions to pursue STEM. Implications and study limitations are discussed, and directions for future research are proposed.

To Evan, Camilla, Audrey, Mackenzie, and all other children born to my friends and family members during the development of this dissertation. May you learn to adopt a "growth mindset" toward your capacity for love, mindfulness, fun, and math.

ACKNOWLEDGEMENTS

This dissertation project has been the most challenging task of my life so far, and I have many people to thank for helping me see it through to its completion. First and foremost, I would like to thank Bianca Bernstein, my advisor and chair, for your exceptional support and active involvement in my professional development since the very beginning of my graduate training. Thank you for accepting no less than the very best from me. I would also like to thank my committee members, Mary Dawes, Richard Kinnier, and Jennifer Bekki for your advocacy of this project from its inception and for your solution-focused advice and assistance.

Thank you to my parents, Milton and Carol Fabert, for always encouraging me to follow my dreams, whether they involve outer space, slug science, stardom, or psychology. Thank you to my aunts, Kathryn Smith and Sherri Lemmi, and to my colleagues, Nedim Yel, Katie Kunze, Ray Reichenberg, and Lyn Ostro, for all of your sound advice, support, and consultation. To my fellow psychologists-in-training from ASU and UC Davis: thank you for making this journey meaningful and enjoyable. Thank you to the UNI 150 instructors for administering the study and to my research participants for participating wholeheartedly. Finally, I would like to thank my husband, Ángel Pinillos, for your immense support and encouragement during this extremely challenging and invigorating endeavor, and for filling these last few years with love and laughter.

TABLE OF CONTENTS

CHAPTER Page

CHAPTER Page

CHAPTER Page

CHAPTER Page

APPENDIX Page

LIST OF TABLES

Table Page

LIST OF FIGURES

Chapter 1: Introduction And Literature Background

Problem Statement

The field of counseling psychology is committed to understanding psychosocial barriers to achievement and applying psychological principles to increase life opportunities for diverse groups. The underrepresentation of women in science, technology, engineering, and mathematics ("STEM") is a particular achievement gap that has received special attention by psychologists, educators, feminists, politicians, policy makers, and economists alike.

This phenomenon (the underrepresentation of women in STEM) is commonly referred to as the "leaky pipeline" (Berryman, 1983), a metaphor implying that women are scarce in STEM because they "leak" out at different junctures along STEM career tracks. In the transition from high school to college, women are more likely than men to change their minds about majoring in science and engineering (CMPWASE, 2006). Women who do obtain STEM-related undergraduate degrees are less likely than men to decide to go to graduate school in STEM or to seek employment in STEM fields; are more likely than men to drop out of STEM PhD programs if they start; and, if they do obtain a PhD, are less likely to apply and be hired to tenure-track positions. Female tenure-track assistant professors are less likely than male tenure-track assistant professors to become tenured (Mason, Stacy, and Goulden, 2003). More recently, theorists have acknowledged that the "pipeline" conceptualization does not adequately describe the often non-linear and non-traditional career paths of women (and sometimes men) (Hewlett, 2007; CMPWASE, 2006). Still, the fact remains that women represent less than a quarter of workers in STEM (National Science Board, 2010) and are concentrated in lower status and lower paying STEM fields, such as the social and behavioral sciences (see Fassinger, 2008 for review).

A lack of participation in high status STEM vocations equates to career and economic disadvantages for women. In fact, the majority of the wage gap is attributable to occupational segregation (AAUW Educational Foundation, 2010). Jobs in science and engineering tend to be well paid and offer good job security and high prestige compared to jobs in other fields in which women are more likely work (Lacey & Wright, 2009; National Science Board, 2008). Furthermore, that middle and upper class White men hold the majority of research and development jobs in STEM means they also hold a monopoly over the ideas, technological creations, and decisions that impact all of our day-to-day lives (Harding, 1991). Including the perspectives of women and minorities can help create new understandings, practices, and products of science.

The failure of research and development in science and engineering to recruit and retain women and minorities at a rate comparable to those of other countries is also a crisis of economic, national, political, and social importance. The National Academy of Science (2007) warns that the U.S. is at risk of losing its status as the leader of technological innovation. The National Science Board (2008) states:

> Demographic structures, stable or shrinking populations, expanding opportunities in other fields, and declining interest in mathematics and science among the young are viewed by governments of many mature industrial countries as a potential threat to the sustained competitiveness of their economies (p. 22).

A steady supply of highly educated workers in science and technology is needed in order to ensure scientific and economic prosperity in the U.S.

The American Psychological Association (APA) Task Force on Women in Academe (2000) formally acknowledged that structural barriers cannot account for systematic gaps in educational and career achievement for women and minorities, a fact that Schmader (2010) described as “the most vexing problem in the struggle for equality” (p. 14). Over several decades, an enormous body of research has developed that helps to explain why women are slow to participate in STEM disciplines despite a relative lack of structural inequities. Women and men’s cognitive abilities are more similar than different (e.g., Hyde, 2005; Spelke, 2005; CMPWASE, 2006). The Committee on Maximizing the Potential of Women in Academic Science and Engineering formed by the Academy of Science reviewed the empirical evidence for innate gender abilities in math and science and concluded that

> studies of brain structure and function, of hormonal modulation of performance, of human cognitive development, and of human evolution have not found any significant biological differences between men and women in performing science and mathematics that can account for the lower representation of women in academic faculty and scientific leadership positions in these fields. (CMPWAS, 2006, p. 2)

Instead, sociocultural reasons best account for the dearth of women in STEM according to Ceci, Williams, and Barntee (2009), who reviewed more than 400 peer reviewed research articles investigating either biological or sociocultural explanations.

In Fassinger’s (2008) conceptualization, sociocultural career barriers for women (and other disadvantaged groups) can be categorized as internal (e.g., decreased self-confidence) or external (e.g., lack of family-friendly policies), active (e.g., intentional discrimination) or passive (e.g., lack of encouragement), and major (e.g., discriminatory hiring) or minor (e.g. offensive jokes). All of these barriers take a psychological toll and contribute to the accumulation of women's career disadvantages in one form or another (e.g. Fassinger, 2008; Fassinger & Gallor, 2006). Psychological career development theories have been helpful in explaining the interplay between the "external" barriers and psychological ("internal") processes that lead to the cumulative disadvantages for women along the STEM pipeline. "Stereotype threat" (Steele, 1997) and "self-efficacy" (Bandura, 1977; 1986) are especially popular constructs in this literature (e.g. Fassinger, 2008; Hackett, 1995; Lent, Brown, Brenner, Chopra, Davis, Talleyrand, Suthakaran, 2001; Lent, Brown, Schmidt, Brenner, Lyons, & Treistman, 2003; Lent, Brown, Sheu, Schmidt, Brenner, Gloster, Wilkins, Schmidt, & Lyons, 2005; Lent, Hung-Bin, Gloster, & Wilkins, 2010; Sekaquaptewa & Thompson, 2003; Spencer, Steele, & Quinn, 1999).

Stereotype threat refers to the anxiety one can experience as a member of a stigmatized social group, particularly when asked to engage in a task related to the negative stereotype associated with the social group (Steele, 1997). Both men and women harbor implicit gender stereotypes about abilities, such as girls' inferior abilities in math (Nosek, Banaji, & Greenwald, 2002) according to the results of a study using the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). Chronic exposure to stereotype threat causes minority students to disengage with academics in general, and women to disengage in male-dominated fields, such as science and engineering (Crocker and Major, 1989; Major, Spencer, Schmader, Wolfe, & Crocker, 1998; Steele, 1997).

Self-efficacy refers to an individual's beliefs about his or her ability to perform specific behaviors (Bandura, 1977; 1986). Self-efficacy predicts achievement above and beyond ability alone (Hackett & Betz, 1989; Hackett, 1995; Zimmerman, 1995).

Women report lower self-efficacy in male-dominated disciplines like STEM (e.g. Betz, Hackett & Betz, 1989; Britner & Pajares, 2006; Pajares, 2005; Tracey, 2002; Wheeler, 1983), especially those who endorse traditional gender roles and the accompanying stereotypes (e.g. Matsui, Ikeda, & Ohnishi, 1989; Rotberg, Brown, & Ware, 1987). Self-efficacy is said to play the mediating role between gender socialization and occupational-related choices (e.g. Hackett, 1995). Women are less likely to express interest in STEM disciplines partly because they have lower self-efficacy in STEM due to gender stereotypes and socialization. This makes the development of occupational interests an issue of social justice, as Nosek, Banaji, and Greenwald (2002) explain:

> As psychologists, we are interested in the mechanisms by which aspirations are undermined–not by a lack of legal protection but in the more basic and fundamental mental processes that determine individual preferences and choices. The operation of such processes can be subversive–they appear to reflect a free and individually determined choice when in fact they reflect group membership, the strength of identity with the group, and beliefs about the capability of the group…. If membership in the groups male or female is associated with differing preferences and choices, no legal remedy to address such disparities is even at issue–an individual, it appears, freely chooses to participate in a system of self-imposed social segregation on the basis of a personal preference (p. 44).

While such psychosocial explanations for the dearth of women in STEM abound in the literature, empirically validated solutions are lacking. Interventions that have been trialed are often unsuccessful because they "fail to impact the central variables that nurture and sustain occupational interests and choices" due to a lack of foundation in theory (Lent et al. 2010, p. 387). Lent, et al., (2010) and others (e.g., Fassinger; 2008; Hackett, Betz, Casas, & Rocha-Singh, 1992; Lent, Lopez, & Bieschke, 1993; Luzzo et al., 1999) argue that self-efficacy should be the target for interventions aimed at increasing interest and persistence in STEM.

Educational researchers are discovering that simple, brief, "social-psychological" interventions can have significant, long-term effects on academic performance and student engagement—enough to greatly reduce racial and gender achievement gaps (see Wilson, 2006; Yeager & Walton, 2011 for review). These interventions show promise for addressing the "leaky pipeline." One type is based on Carol Dweck's "growth mindset" training, in which participants learn via education about the plasticity of the brain to understand intelligence as malleable (controllable), not a fixed trait (Dweck, 2006, 2008; Dweck & Leggett, 1988). Students with growth mindsets tend to persevere in spite of academic challenges because they see the challenges as an opportunity for learning instead of a way to prove or disprove intellectual ability. An experimental study by Aronson, Fried, and Good (2002) found that "growth mindset" training significantly reduced racial achievement gaps between Black and White undergraduate students over the course of their first academic year. Dweck believes that stereotypes about abilities reflect "fixed mindset" beliefs, and that "growth mindset" training might discredit such stereotypes (Good et al., 2003, 2012). Girls and women who have "growth mindsets" may be protected from the effects of gender-math stereotypes on their academic and career self-concepts and development. However, studies assessing Dweck's theory about the impact of growth mindset training to reduce gender achievement gaps have not been experimental (Blackwell, Trzesniewski, & Dweck, 2007; Good, Rattan, & Dweck, 2012) or have used only measures of math performance on a particular task or in a math class (e.g., Dar-Nimrod & Heine, 2007). Therefore, it is unclear whether or not a "growth mindset" intervention might help to increase the "central variables" (Lent, et al., 2010) associated with women's persistence in the STEM pipeline (e.g., STEM self-efficacy).

Literature Review

The first part of this literature review contains a review of the research on the psychosocial barriers for women in STEM. Various psychosocial barriers discourage girls from pursuing math and science in childhood, (e.g., Betz & Hackett, 1981; Eccles, Fassinger, 1985; Freeman, 1979; Frome, Corinne, Eccles, & Bonnie, 2006; Hackett, 1985; Jacobs, & Harold, 1990; O'Brien & Fassinger, 1993) but psychologists are urged to focus on why women's career aspirations plummet later in life. It is in the later stages of career development, such as the college transitions and beyond, that women get stuck or drop out of STEM all together (Hyde, 2005). The next section will review the literature on brief, experimental, psychosocial-educational interventions that show promise in helping to nullify the effects of stereotype threat and increase women's self-efficacy in STEM, including interventions that employ "growth mindset" training.

Psychosocial barriers for women in STEM. Women who initially express interest in STEM often experience a "chilly" academic or professional climate (Hall & Sandler, 1982; Sandler & Hall, 1986) discouraging them from continuing or advancing in their chosen STEM occupation (e.g., Etzkowitz, Kemelgor, & Uzzi, 2000; Herzig, 2004). Explicit and subtle sexism results in intentional or unintentional discriminatory practices in evaluation and promotion (e.g. Betz, 2005; Fassinger, 2002, 2005; Sadker & Sadker, 1994). Receiving less encouragement and assistance from peers and superiors compared to male counterparts (coined the "null environment") can also curb women's career aspirations (Betz, 1989; Crosby, 2007). Work-life conflict and the gendered division of household labor (and associated stereotypes) are also to blame for the leaky pipeline (e.g. Fitzgerald & Harmon, 2001; Harding, 1991; Hollenshead, Wenzel, Lazarus, & Nair, 1996). Person-environment fit theories (eg. Dawis, 1996; Dawis & Lofquist, 1976; Holland, 1973), developmental theories on self-concept and identity (Erikson, 1968; Super, 1990, 1996), and Gottfredson's theory of circumscription and compromise (1981, 1996, 1997) are helpful in understanding the psychological processes for perceiving and reacting to the "chilly" climate and work-life conflict. Self-efficacy (Bandura, 1977, 1986), social cognitive career (Lent, Brown, & Gail Hackett, 1994), and stereotype threat (Steele, 1997) are additional career development theories that have helped to explain how gender stereotypes and socialization cause women to lose confidence and interest in STEM-related courses and careers.

The "chilly" climate. Hall and Sandler (1982) observed that faculty members used sexist humor in the classroom, were less likely to call on female students, asked female students less challenging questions, devalued women's work, and generally responded differently to students according to gender. The researchers warned that this type of subtly and overtly discriminating environment can discourage women from choosing a traditionally male-dominated major and cause women already enrolled in these majors to switch out. Hall and Sandler (1982) coined this hostile learning environment for women the "chilly climate."

Herzig (2004) found, in her literature review, that women and students of color who chose to leave doctoral programs in mathematics had experienced isolation while in school. For example, these students were often left out of social events, had poor relationships with their advisors, and experienced a competitive environment that was contradictory to their preferred style of interaction. Etzkowitz et al. (2000) agree that isolation relates to attrition:

> The overall picture is of a prevailing academic culture that provides inadequate direction and mentoring for women, thereby eroding their self-confidence…The individual is left with the feeling that it is she who is to blame, and this exacts a severe psychic toll including doubts about competency that prevent the successful working through of problems as they arise… Isolation also creates powerlessness, loneliness, and confusion, which, in many cases, leads to dropping out. (p. 83).

Person-environment fit theories. Person-environment fit theories (e.g., Dawis, 1996; Dawis & Lofquist, 1976; Holland, 1973) relate to the interaction between values, skills, interpersonal styles, and environments. Individuals will stay put in an educational or work environment if they find it to be a good fit with their individual characteristics and needs, according to person-environment theorists. Dawis (1996) stressed that the person-environment fit is an evolving process between the individual and the environment, in which both are constantly adjusting in an attempt to meet their needs ("work adjustment theory"). These theories imply that if women are not able to adjust to the STEM educational and/or career environment, they might decide to leave. This is consistent with the claim that the culture of male-dominated STEM disciplines is discouraging to women because it is a "chilly," unwelcoming environment. It is also consistent with sociologists' claim that the culture is contradictory to female socialization (such as being harsh and competitive as opposed to cooperative) (e.g., Harding, 1991; Hollenshead et al.,1996). Further, this theory is consistent with the finding that women are more likely than men to value altruistic career pursuits, and sometimes leave STEM fields because they discover that this is not a value shared by the discipline (Astin, 1979; Preston, 2004).

Work-life balance issues. Work-life conflict and the gendered division of household labor (and associated stereotypes) are also to blame for the leaky pipeline (e.g. Fitzgerald & Harmon, 2001; Harding, 1991; Hollenshead et al., 1996). The conflict between work roles and personal roles is felt more strongly for women than for men, and, in general, women are more likely to make career sacrifices as a way of dealing with this conflict. While the balance between career roles and personal roles is generally more challenging for women than for men across disciplines, it is especially tricky for those pursuing a career in STEM. Hollenshead et al. (1996) and Harding (1991) believe that the nature and culture of academic life in STEM is based on deep-rooted assumptions that can make finding a balance between work and family life particularly challenging. The education and careers of women are also impacted by gender stereotypes, even for women who never intend to be married and/or have a family.

Self-concept, identity, and gender socialization. Bernstein and Russo (2008) believe that the concept of "possible selves" (Markus & Nurius, 1986) can also be extremely helpful in understanding the exit of women from STEM. According to this notion, people behave in ways consistent with their conceptualization of the type of person they desire to become ("desired possible self") and actively avoid behaviors consistent with their conceptualization of the type of person they fear to become in the future ("feared possible self") (Markus & Nurius, 1986). Role models can contribute to one's feared and desired "possible selves." For instance, a woman might begin college and envision her life after graduate school as a faculty member with a healthy, happy family, but she might find that the few female faculty members who are in her department are single, without children, or generally overworked and unhappy. These experiences contribute to the conception of a "feared possible self," and women will make choices (such as switching fields) with the purpose of avoiding this imagined future possibility.

Erikson (1968) and Super (1990, 1996) believe that identity and self-concept are crucial in understanding career development and human behavior. According to these theorists, an individual's identity (or self-concept) is composed of conceptualizations of different life roles (such as daughter, son, student, professional, parent), each carrying a different degree of significance to the overall self-concept. When role-conflict takes place (such as conflict between the demands of the mother role and the student role), an individual will be more likely to sacrifice those roles (or performance in those roles) that hold lower degrees of significance to the self-concept. Super, the leading developmental career theorist, named this concept "life-role salience" (Super, 1990, 1996). Life roles and life-role salience change across a lifetime, according to Super. Erikson (1968) explains how psychosocial influences (such as gender socialization) during adolescence account for the types of roles that become more significant to an individual's self-concept. For example, women tend to be defined and valued in terms of their relation to others (such as their ability to be a wife or caretaker), whereas men are more valued in our society according to their monetary and professional contributions (e.g., Forrest & Mikolaitis, 1986). However, the degree to which and the way gender socialization are reflected in life-role salience (and the career choices made accordingly) will vary for each individual. Women whose student life role becomes a threat to fulfilling a more salient life role could be expected to start to sacrifice performance in the student role, or simply drop this secondary role all together. Super's theory is consistent with claims that women's consideration of family roles might "deepen" (Bernstein & Russo, 2008) at later stages of their education, as it posits that different life roles hold more salience for people at different junctures in life. Preston (2004) also believes that dropping out of science is an easier choice for women to make because society does not judge women based on their occupational success (Cole & Fiorentine, 1991).

Circumscription and compromise. Gottfredson's theory of circumscription and compromise (1981, 1996, 1997) presents a different take on how gender identity and self-concept relate to educational and career choices. Gottfredson views career development as a gradual process of eliminating career choices based on an emerging self-concept. Children learn at a very early age the careers that are considered acceptable and unacceptable according to their gender and social class, and they eliminate career choices from consideration accordingly (a process Gottfredson calls "circumscription"). Once children have developed an ideal range of options based on gender and social class schemas, they slowly give up on the careers within this range that begin to appear inaccessible or unrealistic (called "compromise"). Gottfredson and Lapan (1997) emphasize that an individual's perceptions of her own abilities and resources are often misconceived, but that career sacrifices are nevertheless made according to these perceptions.

Consistent with Super's "life-role salience" hypothesis, Gottfredson and Lapan (1997) hypothesize that individuals will sacrifice career goals if they believe that to do otherwise would be severely threatening to the self-concept. Prestige and compatibility with interests are not as important to self-concept as is fulfilling gender roles, they argue. A woman who leaves a demanding program or career in STEM might perceive that to do otherwise would compromise her ability to succeed as a mother or another womanly part of her self concept. Yet, as Gottfredson and Lapan (1997) caution, “not all changes in aspirations are compromises. Assessing the occurrence and timing of compromise therefore involves distinguishing between changes that represent giving up what one most prefers (compromise) and changing one’s mind about what is most desirable” (p. 430). Theories on possible selves, identity, life-salience, and compromise imply that women avoid or drop out of a STEM pathway in response to a dedication to different life roles.

Self-efficacy. Hyde and colleagues (1990) have argued that even small differences in *confidence* in math ability can have a large cumulative effect on career choices. Self-efficacy is a construct similar to confidence. As explained earlier, self-efficacy refers to internalized beliefs about one’s ability to perform specific behaviors (Bandura, 1977, 1986) and is known to predict achievement above and beyond ability alone (e.g. Hackett, 1995; Hackett & Betz, 1989; Zimmerman, 1995). Self-efficacy plays a major role in interest and values development, academic persistence, and educational and career choices (e.g. Bandura, 1986; Betz & Hackett, 1986; Hackett, 1985; Hackett, 1995; Hackett & Betz, 1989; Hackett & Lent, 1982; Lapan, Boggs, & Morrill, 1989; Lent, Brown, & Larkin, 1984, 1986, 1987; Lent, Larkin, & Brown, 1989; Lent et al., 1993; Pajares & Miller, 1995; Post, Stewart, & Smith, 1991; Tracey, 2002). Women’s occupational self-efficacy in STEM-related disciplines is lower than men’s occupational self-efficacy in STEM-related disciplines, especially in general samples of undergraduate students (e.g. Betz, Hackett & Betz, 1989; Tracey, 2002; Wheeler, 1983).

Self-efficacy is dynamic and affected by personal and vicarious experiences, social learning, and physiological arousal (Bandura, 1986). Personal experience with success or failure is perhaps the most important predictor of self-efficacy (Bandura, 1997; Britner & Pajares, 2006). For example, successful experiences with STEM-related courses build self-efficacy in STEM-related courses and careers. Self-efficacy is also built via vicarious experiences with successful others (Zeldin & Pajares, 2000), such as professional role models. Social persuasion, such as judgments of and feedback and support from parents, teachers, and friends, is another contributor to STEM self-efficacy, one that has been found to be particularly important to girls' and women's STEM self-efficacy (AAUW, 1991; Seymour & Hewitt, 1997; Zeldin & Pajares, 2000). Self-efficacy forms the basis of social cognitive career theory (Lent, Brown, & Hackett, 1994), which emphasizes the importance of influences such as gender socialization, stereotypes, role modeling, and other sociocultural experiences on the development of self-efficacy beliefs and, therefore, on career choices and behaviors.

Gender stereotypes and stereotype threat. Girls and women might lack self-efficacy in STEM due to the prevalence of gender stereotypes, particularly about girls and women's math abilities. The stereotype that women's math abilities are inferior to men's math abilities is well known and endorsed by most Americans according to researchers (e.g. Eccles, Jacobs, & Harold, 1990; Swim, 1994). As recently as 2005, Harvard President Lawrence Summers implied that innate gender differences in mathematical ability accounted for women's status in STEM (Halpern et al., 2007).

Both men and women also harbor implicit stereotypes about girls' inferior abilities in math (Nosek et al., 2002) according to the results of a study using the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998), a computerized measure of implicit stereotypes. These implicit math-gender stereotypes develop as early as age nine (Steffens, Jelenec, & Noack, 2010).

Such stereotypes can have a self-fulfilling outcome, as explained by Kite, Deaux, and Haines: "behavioral confirmation occurs at the final stages of the stereotype loop: when people act in the anticipated stereotypical ways, their behavior reconfirms their initial stereotypes that set the behavioral sequence into motion," (p. 224). The math-gender stereotype can have particularly damaging effects, because math is considered a "critical filter" of women along the career pipeline in STEM disciplines (Ma & Johnson, 2008). Failing to take the necessary prerequisites (especially in math coursework) at the beginning of college leaves women out of the running completely for what could be a professionally and financially rewarding career in the "hard" sciences, and many "soft" sciences as well (Betz, 2001, 2005).

Stereotype threat (Steele, 1997) is one aspect of the self-fulfilling prophecy of stereotypes. Again, stereotype threat refers to the anxiety one can experience as a member of a stigmatized social group, particularly when asked to engage in a task related to the negative stereotype. Stereotype threat is one of the most researched phenomena in the field of social psychology (see Schmader, 2010).

Consistent with Steele's theory of stereotype threat, women tend to perform worse on math tests when they believe that their performance will be compared to men's performance (Johns, Schmader, & Martens, 2005). Being the token minority, as women tend to be in male-dominated fields, is also known to exacerbate the effect of stereotype threat (Sekaquaptewa & Thompson, 2003). The gender gap in performance decreases when women are told explicitly that stereotypes about group ability do not apply in the particular testing situation (that men and women perform equally on the particular task) (in Spencer, et al., 1999), a finding that further corroborates Steele's (1997) theory. Stereotype threat has also been implicated in gender differences on standardized math ability scores (e.g. American Association of University Women, 1995; Coley, 2001; Gonzalez, et al., 2004); Educational Testing Service, 2002). Steele (1997) hypothesized that any social group facing a negative stereotype is vulnerable to stereotype threat in situations where the stereotype would apply. Research suggests that Latino(a) American students are also prone to stereotype threat regarding academic performance (Gonzalez, Blanton, & Williams, 2002). Using similar protocol and procedures as the previous study, Aronson (1999) also showed that men faced stereotype threat when told that they were going to be compared to Asian American students on a test of math ability. Children are also affected by stereotype threat (e.g. Ambady, Shih, Kim, and Pittinsky, 2001; McKown and Weinstein, 2003). Although any social group is vulnerable to stereotype threat, Steele (1997) wrote that Blacks and women face stereotype threat related to academic achievement most harshly in American culture. Claude Steele introduced the concept of stereotype threat in his 1992 article in *The Atlantic Monthly* titled "Race and the schooling of Black Americans." The scholastic underachievement of Black students was not due to poorer intellectual ability but to social and internalized "devaluation" of Black students, according to Steele:

> Like anyone, Blacks risk devaluation for a particular incompetence, such as a failed test or a flubbed pronunciation. But they further risk that such performances will confirm the broader, racial inferiority they are suspected of. Thus, from the first grade through graduate school, Blacks have the extra fear that in the eyes of those around them their full humanity could fall with a poor answer or a mistaken stroke of the pen… Moreover, because these images are conditioned in all of us, collectively held, they can spawn racial devaluation in all of us, not just in the strongly prejudiced. They can do this even in Blacks themselves.

Steele further articulated his theory about stereotype threat in his 1997 article published in *American Psychologist*, emphasizing the role of identity in stereotype threat. The more an individual's sense of identity is associated with a particular scholastic domain, the more motivated an individual will be to succeed in that domain, Steele reasoned. Increased academic motivation leads to increased performance overall. He specified that stereotype threat would only occur in situations allowing for a possibility to confirm a negative stereotype about a social group to which an individual belongs. The fear that the individual might confirm a negative stereotype produces anxiety, stress, and mental preoccupation, which would interfere with performance, and ultimately confirm the stereotype, according to Steele's theory. He explained that this racial devaluation and fear of confirming stereotypes lead Black students to "disidentify" with academia early on in education. "Disidentification" refers to the process by which individuals separate their identity and feelings of self-worth from performance in a negative stereotype-relevant domain (Steele, 1997).

Steele cited his 1995 study with Joshua Aronson as supporting evidence for his theory of stereotype threat. Steele and Aronson (1995) had randomly assigned Black and White students to three different conditions: the stereotype threat manipulation, a comparison condition, and a control condition. Participants in the stereotype-threatinducing condition were told that the experiment was designed to explore "various personal factors involved in performance on problems requiring reading and verbal reasoning abilities," and that they would receive feedback after the experiment about their reading and verbal strengths and weakness. No mention of ability assessment was made to the participants in the control group. In the comparison group, there was also no mention of intellectual ability assessment, but the participants were encouraged to approach their task in the study "as a challenge." The experiment was cast as an exploration of psychological factors related to verbal problem solving to the comparison group. These participants were told that at the end of the study they would receive tips to improve their study habits. Both groups were then asked to complete 30 verbal problems selected from the Graduate Record Examination (GRE) after they received these introductions. According to the results of the analysis with SAT scores held as covariates, White participants performed better on the GRE problems than Black participants in the stereotype threat condition. The performance of the Black participants matched the performance of the White participants in the control condition (in which participants were told that the task was simply a test of psychological factors in test taking and not a diagnostic of intellectual ability).

Because the race-by-condition interaction only reached marginal significance, Steele and Aronson conducted three additional studies with refined procedures (e.g., presenting less GRE problems, allowing the use of a computer, and assessing perceptions of performance). Overall, Black participants who were led to believe that they were about to take a test that would assess their academic ability (stereotype threat manipulation) performed significantly worse than White students in the same condition and all participants in the control condition. Results also suggested that Black participants in the experimental condition were also more likely to make excuses in advance for their performance, showed greater concern about their ability, and showed greater sensitivity to racial stereotypes.

A fourth experiment was designed to test the direct effects of making the race of the participant salient. This procedural design followed the protocol of the control group of the first three studies. However, in this study, half the participants were given a demographic survey with a question addressing the race of the participant (to induce "racial priming,") and half of the participants were given a demographic survey without a question asking about race. Results indicated that Black participants in the racial-priming group performed significantly worse on the GRE task than all other participants. Steele and Aronson presented the results of this series of studies as evidence for stereotype threat (1995).

Schmader (2010) published a review of the theories and research looking at the underpinnings of the process of stereotype threat. Schmader (2010) agreed with Steele's (1997) basic premise of stereotype threat theory: that the possibility of confirming a stereotype in relevant performance-based situations causes individuals to become overly concerned with disconfirming the related stereotype in a way that causes occupational preoccupation. "Ironically," Schmader (2010) explained, "this increased vigilance and control hijacks the same central executive processor (i.e. working memory) needed to excel on a complex cognitive task, producing the very same result—poorer performance—that they are trying to avoid" (p. 14). Various researchers have implicated detriments to executive attention and working memory in the effects of stereotype threat using measures of working memory (e.g. Beilock, Rydell, & McConnell, 2007; Engle, 2002; Schmader & Johns, 2003).

Again, Steele's original theory specified that stereotype threat not only hinders performance but also decreases achievement motivation by causing affected individuals to "disidentify" (Steele, 1997) with stereotype-relevant domains. Disidentification can be temporary, but repeated exposure to stereotype threat can result in chronic disidentification (such as avoiding math classes or dropping out of school). Chronic disidentification is considered a type of defense mechanism to address the inconsistency between one's positive self-concept and a feared outcome. Eccles and Wigfield (1995) and Harter (1990) have shown that either excelling at a particular domain or disidentifying with that domain protects individuals' self-esteem. Crocker and Major (1989) and Major, Spencer, Schmader, Wolfe, and Crocker (1998) have found a similar phenomenon they termed "psychological disengagement." These social psychologists also understand psychological disengagement to be a self-esteem buffer in response to social stigma about intellectual performance.

Major and Crocker (1993) pointed out that disengagement does not necessarily occur if individuals can find an opportunity to discount negative feedback about performance in that domain. In an experimental study, Major et al. (1998) found that self-esteem is protected when Blacks attribute negative performance feedback to prejudice. Similarly, Brown and Josephs (1999) established that women's performance varied as a function of the type of evaluation they were made to believe they were receiving on a math-related task. The first study was designed to induce and establish the occurrence of stereotype threat for the female participants. Women who were told that the evaluation would detect weak math ability performed worse than women who were told that the evaluation was screening for exceptional high math ability. Opposite results were found for men. In the next two studies, the experimenters gave participants an “external handicap” for performance. One group of participants were first told that the task they would be asked to perform required practice and that they would be allowed time to practice the task beforehand. After entering the laboratory, participants were led to believe that the computer used for practice had crashed and that they would not have the chance to practice before the exam. Women’s performance in the “external handicap condition” was stronger compared to women who did not receive this external attribution for potential failure. The experimenters concluded that women were preoccupied with disconfirming stereotypes about women’s poor math abilities, whereas men were preoccupied with confirming stereotypes about men’s high math abilities. The authors also suggested that having an excuse for failure, or the presence of an external handicap, decreased the perceived need to confirm or disconfirm stereotypes, leading to improved performance.

Researchers have also examined the extent to which one’s identity with a particular stereotype-relevant domain impacts the effects of stereotype threat, in order to test Steele’s (1997) original theory that the experience of stereotype threat varies according to the degree to which an individual identifies with the particular domain. Caring about the relevant domain does appear to relate to the degree to which participants experience stereotype threat (e.g., Spencer et al., 1999; Aronson, et al., 1999).

According to the concept of "situational identity," self-definition is not necessarily fixed but can change depending on a context (Markus & Kunda, 1986; Markus, & Wurf, 1987). In 1986, Markus and Kunda presented the self-construct as a partially, but not fully stable construct composed of many different types of self-conceptions of possible selves (such as the "bad self," the "good self," and the "feared self"). Part of the self-concept, what they called "the working self" is alterable according to context. They designed a study to demonstrate just how susceptible the self-concept is to change according to different contextual cues. Different types of self-conceptions can become triggered by different self-relevant cues, they theorized. Different possible selves can also be accessed as a *response* to different situations. Individuals might temporarily choose to access and identify with certain possible selves that help strengthen self-esteem in particularly threatening situations. For example, they argued that it simultaneously is important for the individual to see himself or herself as both unique from and similar to others. Using confederates, these researchers designed an experiment in which the experience of being unique from or similar to others was manipulated. They found that individuals were more likely to conceive of themselves as unique in the similarity-enhancing condition, and were more likely to conceive of themselves as similar to others in the uniqueness-enhancing situations. In one study (Schmader, Whitehead, & Forbes, 2009), highly "math-identified" men and women were recruited to measure how self-identity related to a particular discipline can change under conditions of stereotype threat. Participants were asked to categorize different occupations as fast as they possibly could, according to whether or not the participants could imagine themselves in the particular career. They reasoned that the faster an individual categorized himself or herself as being able to imagine himself or herself as a statistician, the stronger the individual's math concept was. Under a condition in which participants were told that they were about to take a math test that would be graded by a male experimenter, women (not men) were slower to categorize themselves as math-identified. The authors believed that this was evidence that career certainty and career identification is a state that can vary according to context (in Schmader, 2010). Lesko and Corpus (2006) also documented how discounting negative feedback about performance can also help prevent disidentification of high math identified women.

In sum, women experience many psychosocial career barriers, such as unwelcoming academic and professional climates, a lack of positive role models, work-life balance conflict, gender socialization, and subtle and explicit discrimination and stereotyping, which eradicate the sense of belonging and self-efficacy in STEM coursework and careers.

Interventions. Given the literature reviewed above, it is no wonder women's participation in the STEM workforce is lacking, but solutions that are both theoretically-driven and empirically-validated are scarce. Women's confidence in their ability to perform in male-dominated domains (self-efficacy) should be the target of interventions designed to address the issue of the underrepresentation of women in STEM (e.g., Lent et al., 2010).

Certain educational interventions designed by social psychologists with the original purpose of reducing stereotype threat show promise as potentially powerful self-efficacy-building interventions. Yeager and Walton (2011) focused a literature review on interventions that used an experimental design and employed "social-psychological" techniques (versus didactic techniques) to improve academic achievement and reduce racial and gender achievement gaps in educational settings. These are reviewed below and include interventions employing role modeling, self-affirmation, psycho-education about stereotype threat, and psycho-education about intelligence as malleable (or incremental) as opposed to fixed.

Role models. Marx and Roman (2002) found that the effects of stereotype threat on math performance could be mitigated by the presence of women and/or by reminding participants of successful female role models. In their first study, the researchers recruited 22 female and 21 male undergraduates who first completed a pre-test measure of math interest and ability and were asked to report SAT scores for what they were told was a study of math competency. One group of students was assigned to a male test administrator, another group of students was assigned to a female administrator, and both groups were given 25 minutes to complete a set of math GRE scores. An interaction of the gender of the participant and gender of the test administrator was shown using math SAT scores as covariates. Women underperformed compared to men in the male-experimenter condition, but performed equally to men on math performance in the female test-administrator condition. In a second study, participants were led to believe that the experimenter they were about to meet (but never actually did) was either high or low in math competency before the participants completed a set of GRE math problems. Again, math scores were adjusted by self-reported math SAT scores. Women who were told that the female experimenter was high in math competence scored significantly higher on the math test than did the group of women who were told that the female experimenter was not high in math competence. Women performed worse in the low math competency female experimenter condition than men in the same condition. (Men had lower overall scores in the high-competent experimenter condition). The difference between men's and women's math scores in the high math competency condition was not reliable, further suggesting that this intervention helped reduce the effects of stereotype threat. In their third study, the researchers recruited only female students to participate in this study, which was identical to the second study and also included a measure of self-appraised math ability. Women in the high math competency condition (in which they were told that the female experimenter was high in math ability) had significantly higher self-appraisals of math ability. Overall, the researchers took the results of this study to indicate that the presence of (or belief in the presence of) highly math-competent female role models can (at least temporarily) reduce the performance effects of stereotype threat and increase self-appraisals of math abilities.

McIntyre, Paulson, and Lord (2003) conducted a similar study to examine the effects of female role models on math achievement. They hypothesized that if women's performance on a task decreases after being told that women tend to do worse on a task, perhaps women's performance will be enhanced if they are first told that they are about to perform a task at which women tend to excel. One hundred and sixty-two undergraduate women and men received course credit for a study that they were led to believe was being conducted to help standardize GRE scores. Stereotype threat conditions were induced by priming participants to believe that women do not perform as well as men in mathematics. Next, participants were randomly assigned to two different conditions. In one condition, participants were further informed that female participants tend to perform better as participants in psychological experiments (e.g., women tend to produce more reliable data, follow directions better). Participants in the control condition did not receive this information. Participants in both groups were then instructed to complete 34 GRE questions of high difficulty. An assessment measuring perceptions of performance was administered following task completion. Self-reported SAT scores were used as the GRE score covariate. Women in the group that were not told that women are better participants scored significantly worse than both male and female participants in all other conditions. The authors of the study concluded that these results provided evidence "that being reminded of women's general achievements in an unrelated domain increased the participating women's performance on a difficult math test" (McIntyre, et al., p. 86). In a second experiment, researchers used a male experimenter (a female experimenter was used in the first study). Participants in the experimental condition were given literature about different successful women working in different professions. Again, women in the control condition answered significantly fewer GRE questions correctly than women in the other conditions, providing some support for the hypothesis that stereotype threat effects can be alleviated by priming women to reflect on the achievements of other women.

Values-affirmation. Several values-affirmation interventions have been shown to be effective in reducing gender and racial achievement gaps. As stereotype threat is theorized to be a result of a threat to self-worth (Steele, 1997), and reminding participants of their most important values is theorized to help participants affirm self-worth and reduce the effects of stereotype threat. Typically, in these 10 to 15 minute intervention studies, students are randomly assigned to an intervention group (in which they select and write about their most important personal value) or to a control group (in which they select and write about a value that is not particularly important to them). Miyake et al. (2010) carried out a values-affirmation intervention with approximately 400 students in a college physics course and found that the values-affirmation condition significantly decreased the gender achievement gap in physics, as evidenced by the students' grades on examinations and performance tests throughout the semester. Results suggested that this intervention was especially helpful in boosting the achievements of women who indicated an endorsement of negative stereotypes about women's abilities in disciplines such as physics. Another study (Martens et al., 2006) using students enrolled in an introductory psychology course found that values affirmation helped improve women's math performance under stereotype threat conditions. A similar intervention was found to reduce the racial achievement gap between White and Black middle school students at the end of the semester (Cohen et al., 2006). Two years later, the race by intervention interaction effect remained significant: Black students who had been in the values-affirmation group had significantly higher GPAs than Black students in the intervention group (Cohen, 2009). According to these researchers, students in the values affirmation activity were also less likely to be identified by their teachers as "at risk" during this two-year follow up. A values-affirmation intervention was also conducted using a sample of medical students (Woolf, McManus, Gill, & Dacre, 2009) in an attempt to bolster the achievement of non-Black ethnic minority students. This study found that racial achievement gaps were reduced, not because ethnic minority students' performance was bolstered, but because White students performed significantly better in the control group.

Psycho-education on stereotypes and intelligence. The experience of stereotype threat can be induced by reminding research participants about a relevant stereotype (see Steele, Spencer, & Aronson 2002 for review). Johns, Schmader, and Martens (2005) proposed that simply teaching *about* stereotype threat should have the opposite effect. As already reviewed, giving research participants a "situational attribution" for potential failure on a performance task can serve to nullify the effects of stereotype threat (e.g. Brown & Josephs, 1999; Stone, Lynch, Sjomeling, & Darley, 1999). Knowledge of the potential performance effects of stereotype threat might also offer a "situational attribution" for potential failure on a performance task. Johns, Schmader, and Martens (2005) reasoned that giving a fake "situational attribution" for potential failure would be unnecessary if explaining the actual process of stereotype threat would suffice. Like most of the previous experimental studies on the stereotype threat effects on women's math performance, participants were asked to complete a number of math problems taken from the GRE. They were also asked to self-report their SAT scores. One group was told that they would be taking a test of general problem-solving ability and a second group was told that they were taking a math test to assess for gender differences in performance. A third group was also told that they would be asked to complete math problems to assess for gender differences in performance, but they were additionally told, "It is important to keep in mind that if you are feeling anxious while taking this test, the anxiety could be a result of these negative stereotypes that are widely known in society and have nothing to do with your actual ability to do well on the test," (Johns, Schmader, & Martens, 2005, p. 176). Researchers found that women in the third condition outperformed women in the other conditions and performed equally to men in the same condition. (Women in the stereotype threat condition performed worse than men and women in all other groups, consistent with other studies that attempt to induce stereotype threat).

Aronson, Fried, and Good (2002) created another powerful cognitive attribution retraining intervention designed to nullify the effects of stereotype threat. They borrowed ideas from the "growth mindset" training developed by Dweck and colleagues (e.g., Dweck, 1986, 1999; Dweck & Leggett, 1988; Hong, Chiu, & Dweck, 1995). Dweck and her colleagues have demonstrated that achievement motivation varies according to individual beliefs about the nature of intelligence. Children who believe that intelligence cannot be changed are concerned with proving that they are inherently (thus, automatically) capable. They will gravitate toward easier tasks in which they can showcase their innate abilities and avoid, or easily give up when they are confronted with, what they perceive to be insurmountable challenges. Children who believe that intelligence is something that can be gained via effort are more likely to seek out academic challenges and less likely to give up when faced with challenge. As Aronson, Fried, and Good (2002) point out,

> A question that has produced opinions at both extremes concerns the malleability of intelligence—whether it is expandable or fixed. The truth appears to lie somewhere in between; intelligence can be expanded to some degree, but there are limits to its plasticity... But irrespective of the truth— or what psychometricians believe to be the truth—there is very compelling evidence that what a student thinks about intelligence can have a powerful effect on his or her achievement," (p. 115).

Aronson, Fried, and Good (2002) argue that the greater an individual endorses an entity ("fixed") theory of intelligence, the greater the effects of stereotype threat. A performance task will seem less threatening when the chance of poor performance is not indicative of limited ability, but, rather, indicative of the need to acquire additional knowledge and/or increase effort. Thus, the authors hypothesized, endorsing an incremental theory of intelligence will decrease the immediate, anxiety-producing effects of stereotype threat. Further, the chronic effects of stereotype threat, such as academic disengagement, will be reduced, not only because individuals will experience additional performance accomplishments, but because they will experience failure as an opportunity for further learning (as opposed to confirmation of lack of ability). This theory is consistent with self-efficacy theory (Bandura, 1989), in which people are more likely to engage in behaviors that they perceive that they can master with effort, and disengage in behaviors that they learn they cannot master with effort.

Aronson, Fried, and Good (2002) proposed that creating a manipulation in which students learn to endorse an incremental theory of intelligence would weaken the effects of stereotype threat on academic performance and academic disengagement. To test their hypothesis, they taught White and Black students to endorse either a malleable view of intelligence or a fixed view of intelligence. They based their methodologies on theories of persuasion and attitude change to increase the likelihood that their intervention would actually change the participants' theories of intelligence. Persuading an individual to change his/her attitude about a particular behavior is difficult, and achieving the end goal of behavioral change is even more difficult, the authors point out, citing Petty & Wegener (1998) for review. Two-thirds of participants were randomly assigned to two different "pen-pal" conditions in which they were led to believe that they would serve as a mentor to an at-risk youth via a brief period of letter exchanges "to give the younger students encouragement, to show them that successful college students had once been like them but had overcome their struggles to find eventual success” (p. 117). In the “malleable” pen-pal condition, the participants were told that, in addition to what they were planning to include in their letter to their pen-pal, they were to also explain to their pen-pal that research has shown how intelligence is something that can grow “like a muscle” with effort. They watched videos about this theory of intelligence to help them better understand the theory in order to explain it to their pen-pal (so the participants were told). Additional procedures were followed (such as having participants attach a picture of themselves to the letter and having participants write about examples of the intelligence theory from their own lives) in order to maximize attitude change. The same procedures were followed in the control pen-pal condition, but participants were taught about research and theories on domain-specific intelligence. They were instructed to include in their letters the notion that people have different types of intelligence, and that just because you might not succeed in one area or academic subject doesn’t mean you cannot succeed in another. A third control group was also included. Participants in this control group did not participate in an intervention. All participants were asked to sign SAT and GPA release forms at the beginning of the study. After the pen-pal interventions and pen-pal control interventions were complete, participants completed measures assessing beliefs about the malleability of intelligence. Participants filled out this assessment of beliefs about intelligence a second time several weeks later, along with measures of academic identification and experiences of stereotype threat. SAT scores were used as a covariate in data analysis.

Results suggested that although Black students reported less enjoyment of academics overall, academic enjoyment scores were significantly moderated by the intervention. Black students in the malleability of intelligence condition reported significantly higher level of enjoyment of academics. White participants in both pen-pal conditions reported higher enjoyment of academics compared to the non pen-pal control condition, but there was no significant difference of reported levels of academic enjoyment between the two conditions. Also, although Black students reported significantly less identification with academic achievement, Black students who had completed the malleable pen-pal condition reported significantly higher identification with academic achievement than Black students in either condition. Condition effects were not found for White students' scores of academic identification. Black students were more likely to experience stereotype threat. No significant treatment effects were found on the self-reported experience of stereotype threat. Finally, semester GPAs of both White and Black students who participated in the malleable pen-pal condition were significantly higher than the GPAs of students who participated in either control conditions. The authors believed that learning to endorse an incremental theory of intelligence weakened the effects of stereotype threat on academic performance and academic disengagement.

In sum, social psychological interventions using role models, values-affirmation activities, and psycho-education about stereotype threat and about the incremental nature of intelligence have all shown to mitigate academic performance effects theorized to be caused by stereotype threat. In their review titled "Social-Psychological Interventions in Education: They're Not Magic," Yeager and Walton (2011) argue that such brief, low-cost interventions "remove a critical barrier to learning [which] can produce substantial effects on academic outcomes" (p. 275). In fact, part of the stealth and effectiveness of these interventions is in their subtlety and brevity, according to these reviewers. However, these studies typically employ outcome measures of academic performance, but academic performance is only one of many indicators of women's sustained interest and career behaviors in STEM. We also know that women have higher overall undergraduate GPAs compared to men (National Center for Education Statistics, 2001) but still report lower self-efficacy in male-dominated disciplines (Betz, Hackett & Betz, 1989; Wheeler, 1983; Tracey, 2002) and still lose interest in science and engineering at crucial academic transitions (CMPWASE, 2006). Thus, it is not enough to assume that improved academic performance will help increase persistence in male-dominated disciplines.

Some psychological education interventions described above appear to be less promising than others at addressing the underrepresentation of women in STEM. Marx and Roman (2002) and McIntyre, Paulson, and Lord's (2003) role modeling interventions serve as a reminder of the importance of increasing students' exposure to successful women in science and engineering. Unfortunately, there are not enough women in these "hard" sciences. The number of actual female role models decreases during the course of a women's career development, so it is doubtful that these manipulations will have long-term effects. The impact of values-affirmation interventions on academic performance is especially impressive (Martens et al., 2006; Miyake et al., 2010; Cohen et al., 2006). However, the theoretical justification for the use of a values-clarification intervention to bolster self-efficacy is weak, as values do not intuitively relate to the factors associated with self-efficacy, such as personal and vicarious experiences and social persuasion.

Aronson, Fried, and Good's (2002) psychological education intervention based on Dweck's (1986, 1999) "growth mindset training" targets "situational attributions," which are considered central to theories of self-efficacy (Bandura, 1977, 1986) and stereotype threat (Steele, 1997). The types of attributions individuals make about success or failure affect self-efficacy and engagement in a stereotype-relevant domain. Decreases in self-efficacy and disengagement will occur when individuals attribute lack of performance to their own lack of ability (Steele, 1997). These psychological education interventions might help preserve women's self-efficacy in STEM by giving them an external attribution for past or current failures (e.g., "I didn't work as hard as I could have," or "I was experiencing performance anxiety caused by stereotype threat") and a reason to believe they are capable of future success (e.g., "But I can still work to develop skills and abilities in any type of discipline that I choose"). Stereotypes specifically related to women's math abilities are the most pernicious and the most widely-endorsed gender stereotypes regarding women's ability to achieve in the "hard" STEM disciplines (Ma & Johnson, 2008). Explaining that intelligence is not fixed by gender and, in fact, is not fixed at all might directly address and demystify this gender stereotype. Education about the plasticity of intelligence provides a convincing rationale for why it will pay off to work hard, even in science and engineering domains.

Additional research by Dweck and her colleagues provides further support for the use of these psychological education techniques as career development interventions for women. Dweck asserted that learning to adopt a "growth mindset" could protect girls and women from the negative effects of gender-math stereotypes (Dweck, 2006). Consistent with her theory, no achievement gaps in math and science were found between junior high school students or between college students with growth mindsets, but these gaps were present for the group of students with fixed mindsets (Good et al., 2003; Grant & Dweck, 2003; Dweck, 2006). Dweck also found that college women who reported that a growth mindset was communicated in their calculus classrooms appeared to be less likely to be negatively impacted by gender-math stereotypes then women who reported that a fixed mindset was taught in their classrooms (Good, Rattan, & Dweck, 2012). Some research also suggests that growth mindset training can reduce gender gaps in math performance among college students (Dar-Nimrod & Heine, 2007). As the authors of the American Association of University Women's report on women and STEM explain:

> Eradicating stereotypes is a worthwhile but long-term goal. In the meantime, communicating a growth mindset is a step that educators, parents, and anyone who has contact with girls can take to reduce the effect of stereotypes and increase girls' and women's representation in STEM areas. (Hill, Corbett, & Rose, 2010, p. 35)

Given the results of research by Dweck and colleagues (Dweck, 2006; Good et al., 2003; Good, Rattan, & Dweck, 2012; Grant & Dweck, 2003) and Aronson, Fried, and Good (2002), the use of growth mindset training as a STEM self-efficacy building intervention appears promising. Theoretically, women who learn to understand the nature of intelligence as malleable will be less likely to believe and be influenced by negative stereotypes about women's math abilities. This new cognitive attribution framework should protect women's self-efficacy in the areas requiring math ability, including all STEM-related courses and careers. The more confidence women have in their ability to succeed in STEM-related courses and careers, the less likely they might be to "leak out" at critical academic junctures that lead to a successful STEM-related career, such as the transition between high school to college.

Purposes of the Study

The first purpose of the study was to develop a brief, simple, and easily-replicable intervention borrowing from the psychological education and attitude-change techniques used by Aronson, Fried, and Good (2002). The next purpose was to develop and carry out an experimental design to assess the effectiveness of the intervention for 1) convincing participants that intelligence is malleable ("IQ attitude") and that gender stereotypes about intelligence are not accurate ("stereotype disbelief"), and 2) increasing factors associated with women's persistence in STEM, including STEM course and career self-efficacy and intentions to pursue STEM-related disciplines. Additionally, the purpose was to propose a model specifying how these outcomes of interest, including IQ attitude, stereotype disbelief, STEM self-efficacy, and intentions to pursue STEM disciplines, are related to each other, and to assess these hypotheses via path analysis. A final purpose of the study was to assess the impact of the intervention on students' academic achievement.

Research Questions

The following research questions formed the basis of this study with undeclared freshmen undergraduate students:

1. Is self-efficacy in STEM coursework and careers related to beliefs about the nature of intelligence and gender stereotypes about intelligence?
2. Are students who believe that intelligence is malleable less likely to endorse math-gender stereotypes?

3. Does a "growth mindset" training intervention positively influence female students' STEM course and career self-efficacy and intentions to pursue STEM disciplines and associated variables?
4. Does a "growth mindset" training intervention help to improve academic achievement?

Research Hypotheses

The following specific hypotheses will be tested:

H1: At posttest, participants who receive the treatment will have statistically higher IQ attitude scores than participants in the comparison and control groups.

H2: At posttest, participants who receive the treatment will show statistically stronger stereotype disbelief than participants in the comparison and control groups.

H3: At posttest, participants who receive the treatment will report significantly higher STEM course and career self-efficacy than participants in the comparison and control groups.

H4: At posttest, participants who receive the treatment will report significantly stronger intentions to pursue STEM than participants in the comparison and control groups.

H_5: The impact of the treatment on posttest scores of STEM course and career self-efficacy will be moderated by gender.

H_6: The impact of the treatment on posttest scores of intentions to pursue STEM disciplines will be moderated by gender.

H_7: Participants who receive the treatment will show statistically stronger academic performance, as measured by semester GPA, compared to students in the comparison and control groups.

H_8: Participant scores on IQ attitude and stereotype disbelief will be positively related to each other as well as to STEM course and career self-efficacy, and indirectly, positively related to STEM intentions via STEM course and career self-efficacy, as modeled in Figure 1.

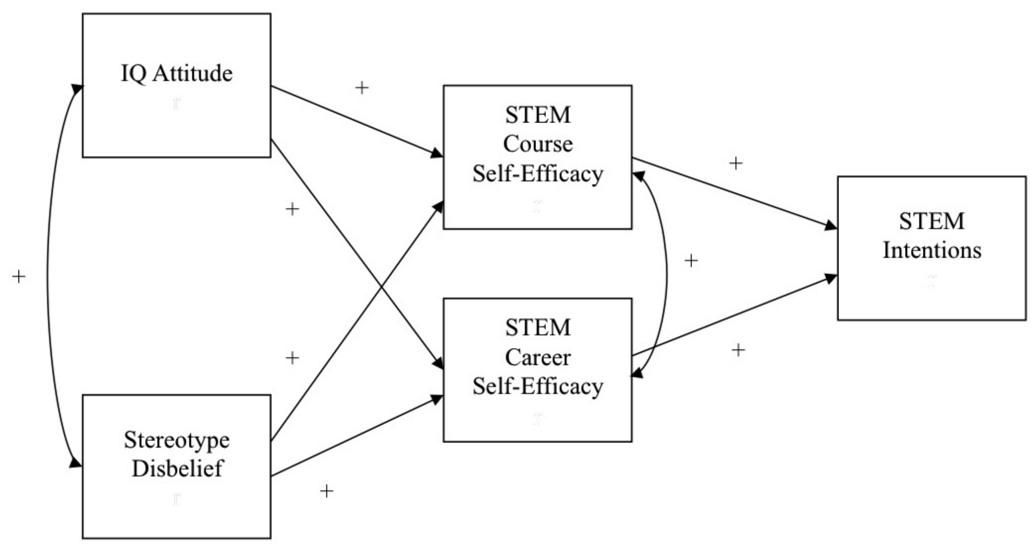


Figure 1. Path model of the hypothesized relationships between five outcome variables.

Chapter 2: Methods

Participants

Undeclared, first-year undergraduate students at Arizona State University were recruited for the study. Students who had transferred from another college, completed a semester or more at ASU, and/or had already successfully declared a major by the beginning of participant recruitment were excluded from participation. Tables 1 and 2 summarize the participant demographics. The final participant pool consisted of 298 women and 191 men with a racial/ethnic breakdown as follows: 5.5% African American/Black; 7.4% Asian American/ Pacific Islander; 60.5% White; 14.5% Hispanic/American/Latino; 2.2% Native American/Alaskan Native/ Hawaiian; 6.1% Multiethnic/Multiracial. Eighteen participants (3.7%) selected the option "decline to answer" when asked to indicate their race/ethnicity. Participants' ages ranged from 17 to 27 and the majority (85%) were 18 years old at the time of the study. Approximately 97% of the sample listed the United States as their country of origin.

Seventy-three percent and 59% of students had taken the SAT and ACT, respectively, with average scores comparable to the 2012 nationwide average scores (see Table 2). The median SAT score reported by participants on the critical reading, mathematics, and writing sections of the SAT ranged between 500-590; comparable to the critical reading, mathematics, and writing section 2012 nationwide average scores of 496, 514, and 488, respectively (CollegeBoard.org, 2012). The average ACT scores on the English and mathematics subtest for the final pool of research participants was 21 with a standard deviation of six points. The average ACT reading and reasoning scores were both 20 with a standard deviation of 6, comparable to the 2012 national average ACT composite score of 21 (ACT, 2013). SAT and ACT median and average scores of participants were similar for both men and women.

Table 1
Demographic Characteristics of Participants (N = 489)

Characteristic	*n* (f, m)	% (f, m)
Gender		
Female	298 61	
Male	191 39	
Age		
17	30 (21, 9)	6 (7, 5)
18	413 (256,157)	85 (86, 82)
19	38 (19,19)	8 (6, 10)
20 – 27	8 (2, 6)	2 (1, 3)
Country of Origin		
United States	472 (286, 186)	97 (96, 97)
Other	7 (12, 5)	4 (4, 3)
Racial/Ethnic Background		
African American/Black	27 (14, 13)	6 (5, 7)
Asian American/Pacific Islander	36 (16, 20)	7 (5, 11)
European American/Caucasian/White	296 (182, 114)	61 (60)
Hispanic American/Latino	71 (47, 24)	15 (16, 13)
Native American/Alaskan Native/ Native Hawaiian	11 (10, 1)	2 (3, <1)
Multiethnic/Multiracial	30 (19, 11)	6 (6, 6)
I decline to answer	18 (10, 8)	4 (3, 4)
Exploratory Track		
Exploratory- STEM	100 (24, 76)	20 (8, 40)
Exploratory- Fine Arts/Humanities/Design	47 (33, 14)	10 (11, 7)
Exploratory- Health and Life Sciences	135 (96, 39)	28 (32, 20)
Exploratory- Social/Behavioral Sciences	190 (140, 50)	39 (47, 26)
Do not know	17 (5, 12)	4 (2, 6)
Class standing*		
Freshman	477 (292, 185)	98 (98, 97)
Sophomore	11 (6, 5)	2 (2, 3)
Junior	1 (0, 1)	<1 (0, <1)

Note. Totals of percentages are not 100 for every characteristic due to rounding. * Class standing denotes number of credits accumulated prior to beginning ASU (e.g., via AP credit or community college courses while in high school). All participants were in their first semester at ASU. f = female, m = male.

Table 2
Demographic Characteristics of Participants (N = 489): SAT and ACT Scores

Characteristic		(f, m)
Took SAT, *n*	358	(214, 144)
SAT Critical Reading score, *Me*	500-590	(500-590; 500-590)
SAT Mathematics score, *Me*	500-590	(500-590; 500-590)
SAT Writing score, *Me*	500-590	(500-590; 500-590)
Took ACT, *n*	289	(177, 112)
ACT English score, *M, SD*	21, 6	(21, 6; 22, 6)
ACT Mathematics score, *M, SD*	21, 6	(20, 6; 22, 7)
ACT Reading score, *M, SD*	20, 6	(21, 6; 22, 7)
ACT Reasoning, *M, SD*	20, 6	(20, 6; 22, 6)

Note. Median (*Me*) SAT score ranges and ACT score means (*M*) and standard deviations (*SD*) are presented for the combined sample of male and female participants as well as separately by gender. f = female, m = male. Some participants took both the SAT and the ACT.

At ASU, all undeclared ("exploratory") students must designate a general interest area of study ("exploratory track") prior to matriculation. The participant pool was divided into "exploratory track" as follows: 20.4% "Engineering, Math, Technology, & Physical Sciences;" 9.6% "Fine Arts/Humanities/Design;" 27.6% "Health and Life Sciences;" 38.9% "Social/Behavioral Sciences." The remaining 3.5% indicated that they did not know their exploratory track status. A described under *Instruments*, items were also included in the demographic questionnaire to assess students' level of major and career "decidedness." On a scale of one (completely undecided) to five (completely decided), participants were asked to indicate the degree to which they were undecided about the major or career they would like to choose. Participants' average scores of the major and career decidedness items were 2.8 and 2.7, respectively, both a standard deviation of 1.3, indicating that they were neither decided nor undecided about their major and career intentions.

Table 3 depicts the percentage of participants who had endorsed current enrollment in specific courses. Just more than half of the participants were taking "first-year composition," a basic writing course. Thirty-two percent of participants were taking a social or behavioral science course and thirty percent were enrolled in a "Humanities/Fine Arts/Design" course. The third most popular course was "enhanced freshman mathematics," a course designed to prepare students for college level mathematics, which 24% of participants indicated they were taking. Surprisingly, 30% of participants indicated that they did not know what classes they were enrolled in at the time of the study. It is possible that students were still figuring out their schedules during the first two weeks of the semester or were unable to reference their schedules while completing the demographic questionnaire.

Table 3.
Percentage of Students Indicating Current Enrollment in Specific Undergraduate Courses*

Course	Treatment	Comparison	Control	Total
Intro to Academic Writing	16	19	12	16
Intro to Academic Writing for Intl Studs	1	0	1	<1
First-Year Composition	54	46	56	51
Advanced First-Year Composition	11	11	22	11
English for Foreign Students	0	0	0	0
Enhanced Freshman Mathematics	25	23	23	24
College Mathematics	7	11	13	10
College Algebra (MA)	14	11	12	12
Pre-calculus	18	17	14	16
Brief Calculus	5	7	5	6
Math for Business Analysis	0	0	1	<1
Calculus for Life Science	4	2	3	16
Calculus for Engineers	6	6	3	5
Calculus w/ Analytic Geometry	4	5	5	6
Modern Differential Equations	0	0	0	0
Linear Algebra	0	0	0	0
Applied Linear Algebra	0	0	0	0
Intermediate Calculus	0	0	0	0
Advanced Calculus I	0	0	0	0
Geometry I	0	0	0	0
Natural Science- Quantitative course (SQ)	4	8	3	5
Natural Science- General course (SG)	12	13	9	11
Social/Behavioral Science (SB) course	30	34	32	32
Humanities/Fine Arts/Design (HU) course	35	27	29	30

Note. *At the time of the study. Participants were able to select as many courses as applied. 4% of participants indicated “other course,” 30% “I do not know.”

Participant recruitment. After Institutional Review Board approval was obtained (Appendix A), undeclared students were recruited from the Downtown, Polytechnic, Tempe, and West campuses of Arizona State University. Since all undeclared students are required to take a UNI 150 (“Major and Career Exploration”) course during their first semester at ASU, participants were recruited exclusively from the 39 UNI 150 classrooms. Recruitment took place during the beginning of the fall semester of 2012 in order to expose students to the intervention early in their college experiences and to minimize potential confounding factors, such as extended exposure to university coursework.

All new ASU students who have not yet officially declared a major are automatically enrolled in ASU's University College until they are accepted into another ASU college to study a major of their choosing. The University College at ASU is the official home for "exploratory" (undeclared), lower division undergraduates to serve the purpose of 1) assisting students in selecting academic majors in a timely manner, 2) enhancing support university-wide for students in transition, and 3) improving student retention and graduation rates (Corey, 2010). Many students at ASU choose to matriculate as undeclared because they are still considering various majors, whereas other students are absorbed by the University College because they have not yet met the prerequisites to declare their top choice majors. Therefore, an item was added to the demographic questionnaire to assess students' career decidedness at the beginning of the fall 2012 semester (see Appendix B). At the time of the study, students' average score rounded up to three on a scale ranging from 1 to 5 points on both the major and career decidedness items (with a score of 5 indicating *complete certainty*), suggesting that students were neither completely decided nor completely undecided about their career goals.

Students register for lower division courses based on their exploratory track in addition to a series of three required, one-unit, University College seminars, typically beginning with UNI 150. Topics covered in UNI 150 include vocational interests and skills, career information resources, and career decision-making strategies. UNI 150 courses are typically taught by Graduate Teaching Assistants (see *Procedures*) and are capped at between 19 to 21 students to allow for individualized attention with the instructor. During the semester the study took place, the course was held for 100 minutes once a week for seven weeks. With the approval of IRB, completion of the study was worked into all UNI 150 courses as a required assignment. All instructors were required to participate in administering the study in their UNI 150 classrooms (see *Procedures*).

Instruments

Demographic Questionnaire. The demographic questionnaire ("DQ") included questions related to students' age, gender, racial/ethnic background, country of origin, SAT or ACT score, exploratory track, and class standing (see Appendix B). In the DQ, participants also indicated how many college units they had completed and the courses they were enrolled in during the current semester. Two questions modeled after those used in Luzzo, Hasper, Albert, Bibby, & Martinelli's (1999) math and science self-efficacy intervention study were also included in the demographic questionnaire to assess major and career "decidedness" on a scale of 1 to 5 points, with a score of 1 indicating "completely undecided" and a score of 5 indicating "completely decided."

Outcome Questionnaire. The outcome questionnaire ("OQ") contained the Index of Malleability (Dweck, Chiu, and Hong, 1995); the Belief Scale from the Stereotype Endorsement Questionnaire by Cutting (2005); the Math/Science Course Self-Efficacy Scale (Cooper and Robinson, 1991); the Math/Science Occupational Self-Efficacy Scale (Cooper and Robinson, 1991); the Intent to Persist in STEM Scale (Toker, 2010); two open ended questions inquiring about participants' academic and career goals; and various filler and distractor items. All measures were completed online via QuestionPro surveys. Students' semester overall grade point averages, retrieved from the university registrar with participants' permission, were also included as part of the measurement data.

IQ Attitude. Participants completed a three-item measure, the "Index of Malleability" (Dweck, Chiu, & Hong, 1995), to assess beliefs about intelligence as malleable ("IQ attitude"), measured on a 6-point scale ranging from 1 (*strongly agree*) to 6 (*strongly disagree*) (Appendix C). An overall score ranging from 1 to 6 is obtained by the average of the three items. Higher scores indicate stronger beliefs in intelligence as malleable. Some research indicates that items framed in terms of beliefs in "fixed" intelligence have higher validity and reliability compared to items framed in terms of beliefs in "incremental," (malleable) intelligence (Leggett, 1985; also see Dweck, Chiu, & Hong, 1995); therefore, the items were created accordingly. The test-retest reliability score was .80 as reported by the authors, and the authors' reported alpha levels ranged between .94 and .98. The coefficient alpha for the current study was .83, indicating "good" reliability (George & Mallery, 2003). The items included in this measure are as follows:

1) You have a certain amount of intelligence and you really can't do much to change it.
2) Your intelligence is something about you that you can't really change that much.
3) You can learn new things but you really can't change your basic intelligence.

Stereotype Disbelief. The "Belief Scale" from the Stereotype Endorsement Questionnaire created by Cutting (2005), based on questions from Pinel's (1999) Stigma Consciousness Questionnaire (STQ), was used to assess endorsement of gender stereotypes about math abilities ("stereotype disbelief") (Appendix D). The STQ was originally designed to assess women's sensitivity to gender stereotypes in token minority status situations. Scores were significantly related to conformity to gender roles. Cutting (2005) subjected these 13 items to exploratory factor analysis with varimax rotation after sampling 336 male and female undergraduates of diverse ethnicities. A two-factor solution was yielded from this analysis, one factor measuring participants' endorsement of stereotypes ("Beliefs") and one indicating acknowledgement of gender stereotypes about math ("Acknowledgement"). Two items irrelevant to male participants were dropped in the final analysis. A Likert-scale rating of 1 (*strongly disagree*) to 7 (*strongly agree*) was used to indicate participants' degree of agreement with six different statements. Items three and five were reverse coded, and scores on the six items were averaged. The final selected items were as followed:

1. I believe to be true the stereotype regarding females as poorer in math than males.
2. Males are better at math than females.
3. The stereotype about females being poorer at math than males is not true.
4. I believe in the stereotype that females are not as capable as males in the math arena.
5. I do not believe the stereotype that females are not as capable as males in the math arena.
6. I endorse the stereotype that females are not as capable as males in the math arena.

As expected by Cuttings (2005), beliefs about math stereotypes were found to relate to scores on perceptions of one's own ability in math. The "Beliefs Scale" factor loadings ranged from .63 to .80 and yielded a Cronbach's alpha of .87. The coefficient alpha for the sample used in the current study was .90 and the split-half coefficient was .87, indicating strong reliability.

STEM Self-Efficacy. Participants completed a modified version of the Math/Science Course Self-Efficacy Scale (Cooper and Robinson, 1991; modified by Cordero et al., 2010) and the Math/Science Occupational Self-Efficacy Scale (Cooper and Robinson, 1991) instruments used by Cordero et al. (2010) and Luzzo (1999) to measure self-efficacy in math and science (Appendices E and F).

STEM course self-efficacy. The Math/Science Course Self-Efficacy Scale (Cooper and Robinson, 1991) was used to assess STEM course self-efficacy. Cooper and Robinson (1991) originally created this 10-item measure based on procedures developed by Betz and Hackett (1981) and Lent et al. (1983). Participants were asked, "Please indicate your confidence in your ability to complete each of the following courses (or an equivalent course) offered at Arizona State University with a B or better." Listed course offerings included chemistry, pre-calculus, calculus, engineering, physics, biology, geometry, statistics, organic chemistry, and computer programming. A 10-point Likert scale ranging from *no confidence at all* (1) to *complete confidence* (10) was used to assess strength of confidence. Mean strengths (ranging from 1 to 10) were calculated for each student's score (total score divided by 10).

Scores on the measure were positively related to college major choice (Hackett & Betz, 1989) and negatively related to mathematics anxiety (Cooper and Robinson, 1991). Test-retest reliability indicators over two weeks were in the low-to-mid 90s, as reported by Hackett and Betz (1989) and Lent, Lopez, and Bieschke (1991). Cronbach alpha coefficients ranging from .92 to .95 have been reported by Betz and Hackett (1993) and Cooper and Robinson (1991). The Cronbach alpha coefficient and the split half coefficient for the sample in this study were .92 and .95 respectively.

STEM career self-efficacy. The Math/Science Occupational Self-Efficacy Scale is a 10-item scale in which participants are asked to indicate their degree of confidence in their ability to complete the job duties associated with 10 different math and science-related fields (engineering, computer science, mathematics, geology, physics, technology, chemistry, astronomy, life sciences, biology) on a 10-point Likert scale ranging from completely unsure (1) to completely sure (10) (Cooper & Robinson, 1991). Mean strengths (ranging from 1 to 10) were calculated for each student's score (total score divided by 10). Alpha coefficients have been calculated at .95 (Luzzo et al., 1999) and .94 (Cooper & Robinson, 1991). Cooper and Robinson (1991) assessed criterion-related validity and found that scores on the measure were positively related to mathematics performance and negatively related to math anxiety and math occupational self-efficacy. Cronbach's alpha was .93, and split half reliability was .95 for the sample in the current study.

Intentions to pursue STEM-related disciplines. Participants' intentions to pursue STEM were assessed with Toker's (2010) 12-item "Intent to Persist in STEM" instrument (see Appendix G). Additional descriptive and qualitative data were collected about participant's intentions to pursue STEM, intentions to pursue different areas of academic discipline, intentions to enroll in different math courses offered at ASU, and specific major and career intentions.

STEM intentions. Toker (2010) originally piloted 12 items reflecting short-term, mid-level, and long-term commitments to pursuing STEM disciplines based on suggestions by Wyer (2003). Averaging participants' scores on all items creates a composite score. A four-factor solution was derived from Principal Axis Factoring with Oblique rotation. The majority of the items (10) loaded on three of the factors categorized by Toker as 1) intentions to pursue a Bachelor of Science in STEM, 2) intentions to pursue a STEM graduate degree, and 3) intentions to pursue a STEM career. Internal consistency reliabilities were, respectively, .83, .84, and .91. Significant small to moderate associations were found between the measure, STEM GPA, realistic interests, investigative interests, and math and science self-concept (Toker & Ackerman, 2011). As the measure is relatively new, I reexamined the items with exploratory factor analysis using principal axis factoring with the current sample of participants. Examination of the scree plot and eigenvalues indicated a one-factor structure with high factor loadings between .77 to .95 and high item communalities ranging from .60 to .89 (see Table H1 in Appendix H). Therefore, for this particular sample, the instrument did not appear to distinguish between participants' short, mid, or long-term goals in STEM but rather whether or not they intended to pursue STEM disciplines at all. The one-factor I named "STEM Intentions" explained 81% of the variance. The content of the items as well as their means, standard deviation, and intercorrelations can be found in Table H2 in Appendix H. That the instrument appears to measure one factor for my sample of participants supports the use of an overall composite score created by averaging scores on all items, as originally intended by Toker (2010).

Intentions to complete mathematics courses. An item was created to obtain descriptive data about students' intentions to complete college level math coursework. The item read: "Of the courses listed below, please put a check by those you plan to take in college." It allowed for multiple response options. Response options included college mathematics, college algebra, pre-calculus, brief calculus, calculus 1, calculus 2, calculus 3, differential equations, linear algebra, math for business analysis, and "I don't know."

Category of discipline of interest. An item was created to assess the area of discipline that participants were pursuing. The item read: "As of today, please indicate the category of discipline that you are *most likely* to pursue." Each official ASU category of interest was included as a response option (https://webapp4.asu.edu/programs/t5/undergrad).

The categories of interest are as follows:

1. Architecture, Construction & Design
2. Artistic Expression & Performance
3. Biological Sciences, Health & Wellness
4. Business, Management & Economics
5. Communication & Media
6. Computing & Mathematics
7. Education & Teaching
8. Engineering & Technology

9. Environmental Issues & Physical Sciences
10. Interdisciplinary Studies
11. Languages & Cultures
12. Law & Justice
13. Social Science
14. Policies & Issues

Specific major and career intentions. To collect descriptive data on participants' specific major and career intentions, the two following open-ended response items were included: "Please write your current career aspiration (or the career you are most likely to pursue in the future)," and "Please write in the major you are most likely to pursue." Response items were tabulated based on the National Science Foundation's Crosswalk of SESTAT (Scientists and Engineers Statistical Data Systems) Education Codes. This system is used by the National Science Foundation for tabulating fields of study for the *National Survey of Recent College Graduates* and the *National Center for Science and Engineering Statistics.*

Academic Performance. Students' overall end of the Fall 2012 semester GPA was retrieved from the registrar following IRB standards of protocol. A separate data set with only the ID codes was created. The ID code information (month of birth, middle initial, last two digits of student ID number) was used to identify each student in order to obtain his or her fall semester GPA. Next, the ID code and GPA data were inserted back into the full data set (without student names) before transforming the ID codes into a new, randomly generated numerical code absent of identifying information. The list with the names and GPA data was subsequently destroyed. As soon as the overall semester GPAs were collected, ID codes were converted into new ID codes without identifying information.

Filler Items. Distractor and filler items and response options were included to mask the true purpose of the study and to be consistent with the purported purpose of "examining the effect of a beta study on virtual mentoring" (see *Research Design* and *Procedures*). The first question in the survey received by the treatment and comparison group participants read: "We are hoping to have the final version of this program complete within the next year. Please indicate whether or not you are interested in being contacted about future mentoring opportunities" with a choice of "yes" or "no." It was followed by an item to assess reading difficulty: "Please rate how difficult the reading material was to understand," on a scale of 1 (*extremely easy*) to 5 (*extremely difficult*) points. Three non-required open-ended questions were included at the end of the survey received by treatment and comparison group participants: 1) "Please comment on anything that was confusing to you and/or that you would like to see changed about the materials, content, or procedure in the pen pal training;" 2) "Please comment on what was particularly valuable to you about the materials, content, or procedure in the pen pal training;" and 3) "Please comment on your experience with this study/assignment." Filler items and response options were also included in the outcome questionnaire received by all participants. For example, items such as "you have a certain type of personality, and you really can't do much to change it" and "people are inherently good" were added to the items from Index of Malleability measure (Dweck, Chiu, & Hong, 1995). Appendices C through G contain each filler item included in the outcome questionnaire in the order presented to the participants.

Research Design

An experimental design was employed to examine the effects of an intervention on the outcome measures. Participants were randomly assigned to treatment, comparison, and control group conditions. Concealing the true purpose of the intervention to the participants is one of the most important aspects of this particular research design (Aronson, Fried, & Good, 2002; Yeager & Walton, 2011). Therefore, only posttest measures were used in order to ensure that the purpose of the intervention was concealed to the participants. Posttest measures were administered immediately following the intervention. Participant GPAs were collected from the registrar at the end of the semester. Table 4 summarizes the design of the study.

Table 4.
Research Design

Group condition	DQ*	Treatment	Posttest**	GPA collection
Treatment	D_1	X_T	D_2	D_2
Comparison	D_1	X_C	D_2	D_2
Control	D_1		D_2	D_2

D = Data; X = Intervention; *Demographic Questionnaire; ** Posttests include measures of IQ Attitude, Stereotype Disbelief, STEM Course Self-Efficacy, STEM Career Self-Efficacy, and STEM Intentions.

Experimental Interventions

Development of group conditions. The intervention conditions were created using online survey software available through a Corporate Edition of an account with QuestionPro.com (2012). An online survey labeled "Pen Pal Letter Part 1" included the information/consent form (Appendix I) and the demographic questionnaire (Appendix B). Next, three separate online surveys were created and each labeled "Pen Pal Letter Part 2." These included the treatment intervention, comparison intervention, or no intervention (control condition) and the outcome questionnaire. As explained further under *Procedures*, all participants were assigned to complete "Pen Pal Letter Part 1" and were then prompted to complete one of the "Pen Pal Letter Part 2" surveys according to random assignment.

Group condition content. I developed the intervention and comparison condition content to be as equal as possible in design, format, length, and reading level (Appendices J through N). Examples from current research findings on motivation, neuroscience, and social influence were included as learning tools. The content was revised according to feedback from colleagues and results of the pilot study (described under *Procedures*). Twenty content screens with between 21 to 334 words per screen were included in the final treatment intervention. The final comparison intervention included 19 content screens with between 22 and 363 words per screen.

Reading difficulty. Microsoft Word readability statistics indicated that the content in each survey read at a 9^{th} to 11^{th} grade level. The majority of the 16 pilot study participants (60%) indicated that the material was easy for them to understand on the item assessing reading difficulty. None of the pilot participants indicated that the material was "extremely difficult" to understand. Therefore, the content was kept at the same reading level in the final study. Results suggested that the group of participants enrolled in the final study also found the material easy to read, as approximately 98% of the treatment group and 99% of the comparison group selected points 1 through 3 (with 1 indicating "extremely easy" and 5 indicating "extremely difficult") on the reading difficulty item.

Pictorial elements. Stock photos from the websites www.morguefile.com (morgueFile, 2012) and www.sxc.hu (Stock.xchng, 2012) were selected to illustrate the concepts taught in the treatment and comparison conditions. Fifteen photos were selected for the treatment condition and 15 photos were selected for the comparison condition (see Appendices J through N).

Interactive components. Forced-answer quiz questions were embedded after every two to three content screens in both the treatment and comparison group conditions to keep participants engaged in the study and accountable for the reading material. An incorrect quiz response was followed by feedback and a review of the relevant material (see Appendix M for an example feedback page). Logic functions were programmed into each quiz question to prompt the survey to skip over this feedback page when a correct answer was selected.

Use of deception. Following Aronson, Fried, and Good's (2002) original design, the study was cast to both treatment and comparison group participants as an effort to connect academically at-risk children with college-age mentors. To set the stage for this deception, the information/consent letter explained that the study aimed "to explore the impact of a training delivered over the Internet" and gave no further information about the study. Next, an elaborate description, background, and mission statement of an online mentoring program ("My Pen Pal") was fabricated (see Appendix J). This narrative included a story of ASU researchers teaming up with teachers and administrators of local school districts to create the mentoring program. A beta version of the study was ready to be piloted with the help of college students willing to serve as mentors, according to the narrative, and these mentors would receive a "mentor training" before being randomly assigned to a mentee from a local middle school identified as academically "at risk." Next, "mentors" would be asked to compose a letter to their designated mentee and submit the letter online, to be later distributed to the "mentees." This mentor program narrative was used in both the treatment and comparison conditions and included six screen pages and three quiz questions.

Treatment intervention "mentor training." Participants assigned to the treatment group received a "growth mindset" tutorial as their "mentor training," inspired by the techniques of Aronson, Fried and Good (2002) and the work of Dweck and colleagues (Dweck, 1986, 1999; Dweck & Leggett, 1988; Hong, Chiu, & Dweck, 1995) (see Appendix K). The treatment intervention training was introduced as a “review of what psychologists know about how to help increase children’s motivation towards learning.” It was divided into three different parts titled “Motivation,” “Techniques to Increase Intrinsic Motivation,” and “How Learning Physically Changes the Brain.”

Treatment intervention “mentor training:” Part one. In part one of the treatment intervention’s “mentor training” (“Motivation”), concepts and facts about achievement motivation were explained, such as the differences between intrinsic and extrinsic achievement motivation. Intrinsic motivation toward learning is important to instill in children at a young age, participants were informed. This section also included an introduction to Dweck’s work on implicit theories of intelligence and an explanation of how children’s theories of intelligence affects their intrinsic motivation toward learning. For example, children who think learning and intelligence are under their control will have more intrinsic motivation toward learning and will be more persistent and successful in school. Next, participants read that gender stereotypes about abilities can also affect children’s achievement motivation and academic persistence.

Treatment intervention “mentor training:” Part two. Part two was titled “Techniques to Increase Intrinsic Motivation.” In this section, participants were told to emphasize effort over ability and to teach children the “true” nature of intelligence. Children who are praised for their effort on a task will be more likely to persist in the face of a challenge compared to children who are praised for ability (Dweck, 1986, 1999; Dweck & Leggett, 1988; Hong, Chiu, & Dweck, 1995). Convincing children that their brains can “grow” to take on new challenges with practice can help them to become more engaged and successful in school and life. Participants were informed about how to demystify racial and gender stereotypes about ability. In total, part two of the treatment intervention mentor training contained four screen pages and two "checkpoint" questions.

Treatment intervention "mentor training:" Part three. The third section of the "mentor training" in the treatment condition ("How Learning Physically Changes the Brain") included an explanation of how learning physically changes the brain. A basic tutorial of the structure and function of a neuron was presented, followed by an explanation of the concept of "neuroplasticity" (a growth or change of a neuron). Neuroplasticity can occur throughout the lifetime when individuals seek out novel, challenging, variety-filled learning situations (Fernandez & Goldberg, 2009). For example, in a brain imaging study involving medical school students, it was discovered that the hippocampus (the part of the brain dedicated to memory) grows larger after medical students study for a major medical exam (Draganski, et al., 2006). Another study found that London taxi drivers grow larger hippocampi (involved in spacial relations) compared to London bus drivers (Maguire, Woollett, & Spiers, 2006), likely because their work involves navigating novel routes. This section contained six screen pages and four "checkpoint" questions.

Comparison condition "mentor training." A tutorial on social influence and persuasive writing skills served as the comparison condition "mentor training" (see Appendix L). Social influence strategies and persuasive writing skills were chosen as the comparison tutorial topics because they seemed to be unrelated to the topic of the treatment condition tutorial but still fit into the fabricated narrative of the study. The comparison group participants read that the training they would be receiving was designed to help them gain the social influence and writing skills needed to write a persuasive letter to their designated "mentees." The training was divided into three parts called 1) "Consider Your Target Audience," 2) "Use the Science of Social Influence," and 3) "Clarify Your Message."

Comparison condition "mentor training:" Part one. The first part of the training ("Consider Your Target Audience") contained a review of strategies to increase the personal relevancy of a message for a particular audience (e.g., Petty & Cacioppo, 1981). Descriptive information on middle school age populations was also presented for participants to consider when composing their letter. This section contained one screen page and one quiz question.

Comparison condition "mentor training:" Part two. Part two ("Use the Science of Social Influence") contained a description of social influence strategies. First, a summary of the work by Solomon Asch (1951) was included to illustrate the concept of "social proof" (the idea that people are more likely to do or think something when they believe it is a popular thing to do or think). Providing "negative social proof" has the opposite effect (Goldstein, 2008; Petty & Cacioppo, 1981). For example, encouraging at-risk students to "beat the odds" may be less effective than reminding them that many children labeled "at risk" go on to become highly successful. A message coming from a trustworthy, likable expert will also be more persuasive (e.g. Chaiken, 1980; Cialdini, 2008; Heppner & Claiborn 1989; Petty & Brinol, 2008). Finally, participants learn to evoke the appropriate amount and type of emotion to increase the persuasiveness of a message (e.g., Breckler & Wiggins, 1992). Part two contained six screen pages and five quiz questions in total.

Comparison condition "mentor training:" Part three. The third and final section of the comparison group mentor training ("Clarify Your Message") presented a review of "prewriting" strategies such as brainstorming, creating an argument, outlining, and organizing. An example of a persuasive academic essay was also included. Four screen pages and two quiz questions made up this section.

Pen pal assignment and letter. At the end of both the treatment and comparison training, participants received instruction to "click 'continue' to receive information about your randomly assigned mentee." Ten mentee profiles were created and programmed into the online surveys to be randomly assigned to each participant. (Participants were informed in the introduction to the mentor training that each mentee would be assigned to more than one mentor). Each profile included a first name, age, grade, and middle school of attendance. Middle school names were chosen from a list of middle schools in the Maricopa County, Arizona, school district (http://www.musd20.org). For every mentee profile that was created, an equivalent mentee profile was created of a mentee of the opposite sex. The profiles also all described an area of academic, personal, and/or motivational struggle faced by the student. Most profiles contained a vignette about a student struggling with or losing interest in math. The full list of mentee profiles can be found in Appendix N. Table 5 contains an example mentee profile.

Table 5:
Example Mentee Profile

Name: Anna
Grade: 7th
Gender: Female
School: Orangewood School (Elementary and Middle School),
Washington School District.
Reason for referral:

> *Anna is a sweet l2 year old 7th grade girl who seems to be slipping in her coursework. According to Anna's fifth and sixth grade teachers, she used to love math courses and was one of the highest achieving math students. During a 6th grade field trip to the ASU Polytechnic campus, Anna became interested in studying alternative energy. She researched the electronic engineering technology major at ASU for her assignment on the field trip experience. I have not heard Anna talk about engineering much at all this year or about her thoughts on attending college. Pre-algebra started out as a struggle for Anna, as it does for many students, and she seems to be giving up completely.*
>
> *- 7th grade instructor*

Participants were encouraged to type the letter to their mentee in a word processing program and cut and paste the letter into a comment box once they were ready to submit it.

Participants received the following prompt upon submitting their letters: "You're almost done! Next, you will answer some additional questions about yourself and about your experience with this training." The first question was the following "filler" item: "We are hoping to have the final version of this program complete within the next year. Please indicate whether or not you are interested in being contacted about future mentoring opportunities" (participants selected "yes" or "no"). Participants were then presented with the outcome questionnaire (see *Instruments*).

Control group condition. A separate online survey was created for students in the control group, which contained only the outcome questionnaire and instructions for submitting proof of completion of the assignment for course credit.

Course credit. Students received five points toward their total class grade for completing the study, the equivalent of 5% of their total grade. Once participants completed the outcome questionnaire, they were directed to a final screen containing a randomly generated ID number along with an indication of study completion. Each survey was also programmed to send a confirmation email to participants once they had completed the study (see Appendix O). Participants had the choice of sending a screen shot or the confirmation email to their UNI 150 course instructor to receive points on the assignment.

Syllabus. In order to satisfy IRB requirements for using data from a classroom assignment for research purposes, the following statement was included in the standardized UNI 150 syllabus under the "class participation" section of the syllabus: "Data collected in this class may be used for research purposes." The study was listed on the course syllabus as a "Pen Pal Letter" assignment worth 5% of the total grade. The syllabus also stated that students must bring their laptops and ASU student ID cards on the second day of class in order to complete the assignment. Refer to Appendix P for an example class syllabus.

Instructor training. The majority of University College instructors are master's and doctoral students in the counseling and counseling psychology programs of the School of Letters and Sciences at Arizona State University. All University College instructors were required to participate in a mandatory, 40-hour, weeklong training on teaching strategies and course curriculum, held a week prior to the beginning of the Fall 2012 semester. During this training, the instructors received a handout with specific instructions about how to administer the study. Minimal information was provided about the nature and purpose of the study other than indicating that it is part of a dissertation research project. The handout explained that all UNI 150 students would be required to complete the study, and instructors should direct students with questions about the study to contact the researcher via email. Also, instructors were informed they should discourage students from to spending class time discussing their experiences with the assignment. The handout also contained a script for introducing the study, the web address for students to use to access Part 1 of the study, and a copy of the information letter and unique ID code instructions for the instructors' reference. This handout is included in Appendix Q.

Procedures

Pilot study procedures. A pilot study was conducted with first-year undergraduate students to test out the technical aspects of the survey; assess whether or not the "online mentor program" narrative was believable to participants and whether or not the writing was of an appropriate reading level; ensure that data recorded properly via the QuestionPro data collection functions; and estimate the length of time required for completion. Students enrolled in one of two introductory psychology courses at a local community college were recruited on the first day of class of the Fall 2012 semester. Students were offered two points extra credit for participation. Sixteen participants started and completed the pilot study. The debriefing statement was read to the pilot study participants at the end of the Fall 2012 semester (see Appendix R). Results suggested that the content was at an appropriate reading level and that the deception was believable to the participants. Technical issues with the online survey were identified via the pilot study and addressed prior to the official recruitment period. Specifically, participants had difficulties logging out correctly in order to save their work and return to it at a later time, and the survey was revised accordingly to improve the save and exit functions. Instructions on how to submit the mentor letter were also revised for clarity based on feedback from the pilot study participants. Pilot study participants took an average of 50 minutes to complete the study.

Final study procedures. On the first day of UNI 150, instructors were supposed to remind students to bring in their laptop computers (if they had one) and their ASU student ID cards to the next class period. Instructors were asked to save 15 minutes of class time during the second UNI 150 class period to allow students to begin the study. During this time, instructors were asked to read the following prompt:

> In addition to the Kuder & Major Paper, the Pen Pal Letter assignment is due next week. This assignment is your first opportunity to participate in one of the many different scholarly research projects currently underway at ASU. You will complete the first part of the assignment now. Go ahead and take out your computers, for those who have them, and type in the following link: https://UNI150PenPalLetterPart1.questionpro.com. This link will direct you to additional information and instruction. You will receive a link to the second part of the assignment via email approximately 24 hours after you complete Part 1. Plan to spend up to one and a half hours on the second part of this assignment. When you are finished, you will receive an electronic Certificate of Completion. You must email this Certificate of Completion to me by the start of the next class period to receive full credit on the assignment.

Students without laptops were allowed to use any available classroom computer or, if no computer was available, were instructed to complete Part 1 after class and as soon as possible. It is not known how many students, if any, did not have access to a computer during class. As described earlier, “Part 1” contained the information/consent letter, instructions for creating a unique Participant ID Code, and the demographic questionnaire. Instructors were supposed to also remind students to write down their Participant ID Codes and to keep the codes in a safe place because they would need these codes again to complete the assignment. Participants spent an average of nine minutes completing Part 1.

As participants completed Part 1 of the study, they were each randomly assigned to treatment, comparison, or control groups using an online random number generator service (StatTrek.com, 2012). The identification codes participants had created as part of Part 1 were then programmed into the treatment, comparison, and control condition surveys as the participants’ unique login codes. Next, participants were sent an email containing a hyperlink to either the treatment, comparison, or control group survey (“Pen Pal Letter: Part 2”) according to random assignment (see Appendix S).

Participants were told to contact the researcher directly if they had problems with their access codes or for any other technical issues. Reminder emails were sent throughout the week to encourage students to complete “Pen Pal Letter Part 2” by the beginning of their next class period (see Appendix T). Part 2 of the treatment, comparison, and control group conditions took participants an average of 54, 52, and 14 minutes respectively. As described above, students were automatically sent email verification once they successfully completed the study.

GPA collection. Grades of participants who had given consent were obtained at the end of the semester via the Registrar (see *Academic Performance* under *Instruments*).

Debriefing. Students were emailed a debriefing statement at the end of the semester after GPA data were collected. Refer to Appendix R for the IRB-approved debriefing statement.

Analyses

Analysis of variance was used to check for preexisting differences on demographic characteristics between treatment, comparison, and control groups. To assess treatment fidelity, I conducted descriptive analyses on participants' answers to the quiz questions (embedded in the treatment and comparison interventions) and on the word count of the letters written by treatment and comparison group participants. I also reviewed the content of the letters written by participants to their "mentees." These steps were intended to provide some indication about whether or not students were paying attention to the content in the tutorials and whether or not they were taking the letter writing assignment seriously. As a final manipulation check, I reviewed the responses to open-ended questions about the participants' experiences with the study, looking for indications that participants were suspicious about the mentee program narrative.

Next, I performed descriptive analyses on all outcome measures. Analysis of variance was then used to examine the effect of group condition on all outcome variables (IQ attitude, stereotype endorsement, STEM course self-efficacy, STEM career self-efficacy, STEM intentions, and GPA) in order to examine hypotheses one through seven. These ANOVAs were conducted using all participants. As I was particularly interested in outcomes for women, the ANOVAs were run again post-hoc with the data split by gender. I also conducted some post-hoc analyses to examine the effects of group condition on the outcome variables with STEM track, major decidedness, and career decidedness included as covariates in analysis of covariance (ANCOVA). (I coded participants' "STEM track" as 1 = STEM tracked, 0 = not STEM tracked). The above analyses were conducted using IBM's Statistical Package for the Social Sciences (SPSS) (Version 22).

Next, path analysis using robust maximum-likelihood (MLR) estimation was used to determine the fit of the proposed model of the relationships between the outcome variables IQ attitude, stereotype disbelief, STEM course self-efficacy, STEM career self-efficacy, and STEM intentions (hypothesis eight; see Figure 1) using Mplus Version 7 (Muthén & Muthén, 2012) statistical analysis software. Path analysis is a form of structural equation modeling (SEM) in which each construct is represented by a single indicator (Kline, 2012). I chose to use path analysis instead of multi-stage regression to capture both direct and indirect effects of the variables and assess the strengths of the paths in the model simultaneously (Ahn, 2002). Composite scores on the "Index of Malleability" (Dweck, Chiu, & Hong, 1995), "Belief Scale" (Cutting, 2005), "Math/Science Course Self-Efficacy Scale" (Cooper & Robinson, 1991), "Math/Science Occupational Self-Efficacy Scale" (Cooper & Robinson, 1991), and "Intent to Persist in STEM Scale" (Toker, 2012) were used as indicators of IQ attitude, stereotype disbelief, STEM course self-efficacy, STEM career self-efficacy, and STEM intentions, respectively. My sample size of close to 500 participants far exceeded the minimum recommended sample size of 200 for path analysis (Hair, Anderson, Tatham, & Black, 1998).

Chapter 3: Results

Participant Retention

For the fall of 2012, 39 UNI 150 courses were offered during the first seven weeks of the semester. A total of 650 students enrolled. Of the 650 students enrolled, 53 did not begin the study for unknown reasons (they may have been absent the day the study was assigned). Of the 597 students who began the study, only 76 did not complete the study for unknown reasons, resulting in an 87% retention rate. Twenty-one sets of participant responses were removed because they indicated in the DQ that they were not in their first semester of college at the time of the study, which means they did not meet the participant selection criteria. Another nine sets of participant responses were removed because their entire data set did not record properly in the QuestionPro data files and responses were illegible. This left a total of 489 participants. Of the total 489 participants, 408 gave the researcher permission to access their end-of-fall-2012 semester GPAs. The participation retention flowchart is depicted below in Figure 2.

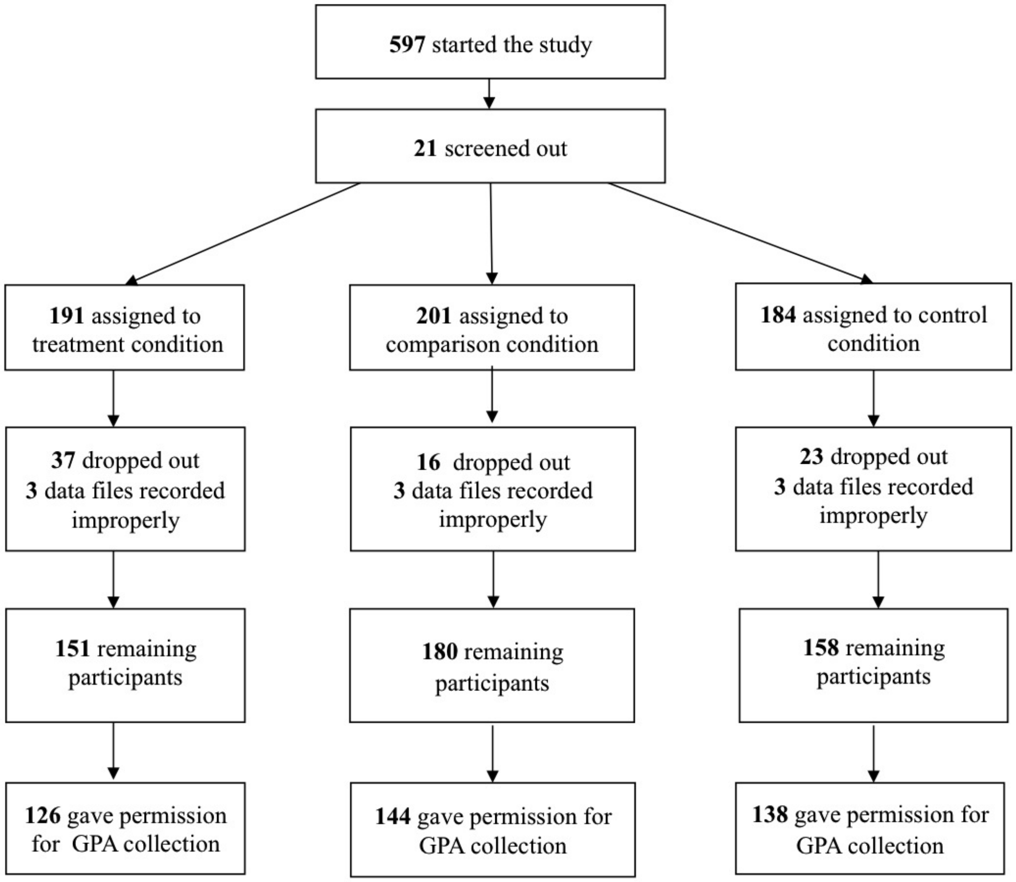


Figure 2. Participant attrition flowchart.

Students who did not complete the study were similar to completers in make up along all known demographic characteristics, including gender, age, race, class standing, SAT and ACT score, academic tracking, and career decidedness (see Tables 6 and 7).

Table 6
Demographic Characteristics of Retained (N = 489) and Lost (N = 87) Participants

	Retained Participants				Lost participants			
Characteristic	*n*	(f, m)	%	(f, m)	*n*	(f, m)	%	(f, m)
Gender								
Female	298		61		52		60	
Male	191		39		35		40	
Age								
17	30	(21, 9)	6	(7, 5)	4	(4, 0)	5	(8, 0)
18	413	(256,157)	85	(86, 82)	74	(43, 31)	85	(83, 89)
19	38	(19,19)	8	(6, 10)	9	(5, 4)	10	(10, 11)
20 – 27	8	(2, 6)	2	(1, 3)	0	0		
Country of Origin								
United States	472	(286, 186)	97	(96, 97)	83	(50, 33)	95	(96, 94)
Other	17	(12, 5)	4	(4, 3)	4	(2, 2)	5	(4, 6)
Racial/Ethnic Background								
African American/Black	27	(14, 13)	6	(5, 7)	3	(0, 3)	3	(0, 9)
Asian American/Pacific Islander	36	(16, 20)	7	(5, 11)	3	(1, 2)	3	(2, 6)
European American/ Caucasian/White	296	(182, 114)	61	(61, 60)	56	(35, 21)	64	(67, 60)
Hispanic American/Latino	71	(47, 24)	15	(16, 13)	13	(9, 4)	15	(17, 11)
Native American/Alaskan Native/Native Hawaiian	11	(10, 1)	2	(3, <1)	4	(3, 1)	5	(6, 3)
Multiethnic/Multiracial	30	(19, 11)	6	(6, 6)	3	(2, 1)	3	(4, 3)
I decline to answer	18	(10, 8)	4	(3, 4)	4	(2, 2)	5	(4, 6)
Exploratory Track								
Exploratory- STEM	100	(24, 76)	20	(8, 40)	19	(3, 16)	22	(6, 46)
Exploratory- Fine Arts/ Humanities/Design	47	(33, 14)	10	(11, 7)	12	(8, 4)	14	(15, 11)
Exploratory- Health and Life Sciences	135	(96, 39)	28	(32, 20)	26	(17, 9)	30	(33, 26)
Exploratory- Social/ Behavioral Sciences	190	(140, 50)	39	(47, 26)	26	(22, 4)	30	(42, 11)
Do not know	17	(5, 12)	4	(2, 6)	4	(2, 2)	5	(4, 6)
Class standing*								
Freshman	477	(292, 185)	98	(98, 97)	87	(52, 35)	100	
Sophomore	11	(6, 5)	2	(2, 3)	0		0	
Junior	1	(0, 1)	<1	(0, <1)	0		0	

Note. Totals of percentages are not 100 for every characteristic due to rounding. * Class standing denotes number of credits accumulated prior to beginning ASU (e.g., via AP credit or community college courses while in high school). All participants were in their first semester at ASU. f = female, m = male.

Table 7

Demographic Characteristics of Retained (N = 489) and Lost (N = 87) Participants: SAT and ACT Scores

Characteristic	Retained Participants	(f, m)	Lost participants	(f, m)
Took SAT	358		63	
SAT Critical Reading score, *Me*	500-590	(500-590; 500-590)	500-590	(500-590; 500-590)
SAT Mathematics score, *Me*	500-590	(500-590; 500-590)	500-590	(500-590; 500-590)
SAT Writing score, *Me*	500-590	(500-590; 500-590)	500-590	(500-590; 500-590)
Took ACT	289		59	
ACT English score, *M, SD*	21, 6	(21, 6; 22, 6)	22, 5	(21, 5; 24, 6)
ACT Mathematics score, *M, SD*	21, 6	(20, 6; 22, 7)	23, 6	(21, 5; 24, 6)
ACT Reading score, *M, SD*	20, 6	(21, 6; 22, 7)	22, 6	(21, 5; 24, 6)
ACT Reasoning, *M, SD*	20, 6	(20, 6; 22, 6)	22, 5	(20, 4; 24, 5)

Note. Median (*Me*) SAT score ranges and ACT score means (*M*) and standard deviations (*SD*) are presented for the combined sample of male and female participants as well as separately by gender. f = female, m = male. Some participants took both the SAT and the ACT.

Table 8 depicts the demographic data split according to group condition and the results of one-way ANOVAs used to assess for significant differences between groups on each demographic characteristic (except for SAT scores, as item response options were presented in ranges). Results of one-way ANOVAs failed to detect significant differences between group conditions on any demographic characteristic. The median SAT score range responses were identical for the critical reading, mathematics, and writing SAT sections between and across group conditions, and were identical for the group of women and men (500-590). Therefore, I moved forward with the analysis under the assumption that there were no preexisting differences between the groups on any demographic characteristic.

Table 8

Demographic Characteristics by Group Condition and Results of One-Way ANOVAs

Characteristic	Treatment	(f, m)	Comparison	(f, m)	Control	(f, m)	*p*
Population	151	(95,56)	180	(110,70)	158	(93,64)	
Sex (% female)	63		61		59		.77
Age, *M*	18	(18, 18)	18	(18, 18)	18	(18, 18)	.34
Ethnicity (% White)	61	(66, 52)	56	(49, 65)	66	(70, 60)	.80
Exploratory status (% STEM)	22	(10, 43)	18	(9, 43)	22	(10, 39)	.68
Major Decidedness, *M*	2.7	(2.6, 3.0)	2.9	(2.8, 2.9)	2.8	(2.5, 3.1)	.63
Career Decidedness, *M*	2.7	(2.6, 2.9)	2.8	(2.8, 2.7)	2.6	(2.5, 2.9)	.68
Took SAT (%)	73	(72, 75)	75	(72, 80)	72	(72, 71)	.77
Took ACT (%)	65	(61, 71)	54	(58, 49)	59	(59, 59)	.16
ACT English score, *M*	21	(22, 20)	21	(20, 23)	22	(21, 23)	.42
ACT Mathematics score, *M*	21	(21, 20)	20	(19, 24)	21	(20, 23)	.83
ACT Reading score, *M*	21	(22, 20)	21	(20, 23)	22	(21, 20)	.84
ACT Reasoning score, *M*	20	(21, 20)	20	(19, 22)	20	(19, 23)	.93

Note. Totals of percentages are not 100 for every characteristic due to rounding. f = female, m = male. Some participants took both the SAT and the ACT.

Missing Data

Not all participants gave permission for the researcher to access their end-of-the-semester GPAs, so only consenting participants were included in the ANOVA examining the effect of group condition on GPA. The items assessing the remaining outcomes of interest were programmed as “forced-answer.” Therefore, there were no additional missing data except for scores that did not appear to have recorded properly in the data file. Eight percent of the final participant data sets contained one or more items measuring STEM career self-efficacy with scores that did not record properly. One percent of participant data sets contained scores that were not recorded properly on one or more items measuring stereotype disbelief as well as IQ attitude. No scores were missing for the items used to assess STEM course self-efficacy or STEM intentions. To handle these missing data, any participant who had a missing item on a score was given a missing scale score. This “full information” method for handling missing data is considered robust compared to other methods for handling missing data and preferable when the quantity of missing data is small enough to allow for it (Enders, 2010).

Evidence Of Treatment Fidelity

The interventions appear to have been delivered as intended. Students in both the comparison and treatment groups completed the reading comprehension quiz questions with 90% accuracy, consistent with the assumption that students read and comprehended the content. Qualitative analysis of the material suggested that the letter writing manipulation was also successful. Most students composed a letter of three paragraphs or more (as instructed) to a person they appeared to have believed was a middle school student. The treatment group participants commonly encouraged their pen pals to challenge themselves in school because their brain is “like a muscle: it grows with practice.” Themes from the comparison group letters related to working hard in spite of obstacles and the importance of obtaining an education. Comparison group letters did not contain references to neuroplasticity or to the malleable nature of intelligence or statements about the brain being “like a muscle.” Most letters from both groups included a personally relevant example. However, the comparison group participants wrote somewhat longer letters on average, likely because they had just completed a tutorial on writing: comparison group letters contained between 144 and 951 words, with a mean of 409, whereas treatment group letters contained between 22 and 960 words, with a mean of 355. Lengths also varied greatly by letter. The standard deviations of the word counts were 212 and 149 for the treatment and comparison groups respectively. It is possible that the more students wrote, the more they were impacted by the intervention. However, it seems reasonable to assume that the act of writing four additional sentences on average did not provide an advantage to the comparison group participants on the outcomes of interest. In response to an open-ended question about the participants’ experience with the training, only two participants indicated that they were skeptical of the true nature of the study.

Descriptive Results

Descriptive data are presented in Table 9. Data normality was assessed by visual inspections of scatterplot data and with skewness and kurtosis statistics. The negative kurtosis value of scores on STEM intentions of greater than one reflects a slightly flat data distribution of STEM intentions. The negative skewness statistic for GPA was greater than one, reflecting the generally high GPAs of this sample of participants. All skewness and kurtosis statistic values are lower than the absolute value of two and are therefore considered to be of an acceptable range. As reported under *Instruments*, the reliability coefficients of the outcome measures were all in the acceptable to high range (.83 - .98). On average, students tended to endorse the belief that intelligence is malleable and showed disagreement about gender stereotypes about abilities. On average, students reported neither weak nor strong STEM self-efficacy and neither weak nor strong intentions to pursue a STEM discipline. Students' average academic achievement as measured by fall semester GPAs was a solid 3.0. Table 10 presents the means and standard deviations of the outcome variables by group condition and by gender. Table 11 presents the bivariate correlations between outcome variables and between the demographic variables gender, major tracking, major decidedness, and career decidedness.

Table 9
Descriptive Statistics

Variable	Alpha	M(SD)	95%CI	Min	Max	Range	Skewness	Kurtosis
IQ Attitude	.83	4.37 (1.13)	[4.27, 4.48]	1	6	5	-.351	-.728
Disbelief	.90	5.36 (1.24)	[5.24, 5.47]	2.2	7	4.8	-.318	-.944
Course SE	.92	6.08 (2.13)	[5.88, 6.28]	1	10	9	-.200	-.607
Career SE	.93	5.05 (2.18)	[4.85, 5.26]	1	10	9	.040	-.613
Intent	.98	3.23 (1.63)	[3.07, 3.38]	1	6	5	.040	-1.38
GPA	--	3.00 (0.83)	[2.92, 3.08]	0	4	4	-1.105	1.132

Note. Disbelief = Stereotype Disbelief; Course SE = STEM Course Self-Efficacy; Career SE = STEM Career Self-Efficacy; Intent = STEM Intentions. IQ Attitude scores range from 1 to 6, with higher scores indicating stronger beliefs in malleable intelligence; Stereotype Disbelief scores range from 1 to 7, with higher scores indicating disagreement with gender stereotypes about math ability; STEM Course Self-Efficacy ranges from 1-10, with higher scores indicating stronger self-efficacy in male-dominated fields; STEM Career Self-Efficacy ranges from 1-10, with higher scores indicating stronger self-efficacy in STEM careers; Intentions to Pursue STEM ranges from 1 to 6, with higher scores indicating stronger intentions to pursue STEM; GPA ranges from 0 to 4.

Table 10

Means and Standard Deviations of Six Dependent Variables and Results of One-way Analysis of Variance Results for the Effect of Group Condition

	Treatment		Comparison		Control		Overall Mean		ANOVA Results		
Variable	*M* (SD)	*n*	*M* (SD)	*n*	*M* (SD)	*n*	*M* (SD)	*n*	*F*	*p*	η^2
IQ Attitude	**4.75 (1.10)**	150	**4.19 (1.08)**	180	**4.20 (1.14)**	158	**4.37 (1.13)**	488	**12.71**	**<.001**	**.050**
Women	4.88 (.97)	94	4.28 (1.10)	110	4.22 (1.10)	93	4.45 (1.10)	297	11.51	<.001	.073
Men	4.52 (1.28)	56	4.06 (1.06)	70	4.18 (1.20)	65	4.24 (1.18)	191	2.45	.089	.025
Stereotype Disbelief	**5.55 (1.22)**	150	**5.23 (1.18)**	180	**5.28 (1.30)**	158	**5.36 (1.24)**	488	**3.13**	**.045**	**.013**
Women	5.70 (1.20)	94	5.31 (1.20)	110	5.51 (1.21)	93	5.49 (1.21)	297	2.73	.067	.018
Men	5.30 (1.21)	56	5.10 (1.15)	70	4.95 (1.37)	65	5.11 (1.25)	191	1.18	.309	.012
STEM Course SE	**5.80 (2.04)**	151	**6.13 (2.24)**	180	**6.15 (2.10)**	158	**6.08 (2.13)**	489	**1.31**	**.271**	**.005**
Women	5.49 (1.89)	95	5.65 (2.21)	110	5.69 (2.20)	93	5.61 (2.11)	298	0.25	.782	.002
Men	6.33 (2.19)	56	6.87 (2.10)	70	6.82 (1.75)	65	6.70 (2.02)	191	1.28	.280	.013
STEM Career SE	**4.84 (2.29)**	137	**4.95 (2.18)**	171	**5.37 (2.04)**	143	**5.05 (2.18)**	451	**2.38**	**.094**	**.011**
Women	4.42 (2.18)	86	4.33 (2.03)	104	4.94 (2.02)	81	4.54 (2.08)	271	2.18	.116	.016
Men	5.57(2.32)	51	5.91 (2.07)	67	5.94 (1.94)	62	5.82 (2.09)	180	0.54	.584	.006
STEM Intentions	**3.11 (1.68)**	151	**3.18 (1.65)**	180	**3.26 (1.57)**	158	**3.23 (1.63)**	489	**0.33**	**.719**	**.001**
Women	2.75 (1.70)	95	2.76 (1.58)	110	2.88 (1.60)	93	2.80 (1.62)	298	0.19	.829	.001
Men	3.71 (1.47)	56	3.85 (1.54)	70	3.80 (1.39)	65	3.79 (1.46)	191	0.13	.883	.001
GPA	**3.10 (0.73)**	126	**3.03 (0.81)**	144	**2.86 (0.91)**	138	**3.00 (0.83)**	408	**3.18**	**.043**	**.015**
Women	3.19 (0.71)	80	3.04 (0.81)	91	2.93 (0.95)	84	3.05 (0.84)	255	2.10	.124	.016
Men	2.95 (0.74)	46	3.03 (0.82)	53	2.75 (0.84)	54	2.91 (0.81)	153	1.70	.186	.022

Note. IQ Attitude scores range from 1 to 6, with higher scores indicating stronger beliefs in malleable intelligence; Stereotype Disbelief scores range from 1 to 7, with higher scores indicating disagreement with gender stereotypes about math ability; STEM Course Self-Efficacy ranges from 1-10, with higher scores indicating stronger self-efficacy in male-dominated fields; STEM Career Self-Efficacy ranges from 1-10, with higher scores indicating stronger self-efficacy in STEM careers; Intentions to Pursue STEM ranges from 1 to 6, with higher scores indicating stronger intentions to pursue STEM; GPA ranges from 0 to 4.

Table 11
Bivariate Correlations between Variables

Variable	1	2	3	4	5	6	7	8	9
1. Gender	---								
2. STEM Tracking Status	-.38**	---	---	---	---	---	---	---	---
3. Major Decidedness	-.12**	.08	---	---	---	---	---	---	---
4. Career Decidedness	-.07	.04	.85**	---	---	---	---	---	---
5. IQ Attitude	.09*	-.06	-.06	-.01	---	---	---	---	---
6. Stereotype Disbelief	.15**	-.06	-.06	.02	.36**	---	---	---	---
7. STEM Course Self-Efficacy	-.25**	.39*	.06	.04	.13**	.11*	---	---	---
8. STEM Career Self-Efficacy	.29**	.41**	.05	.01	.06	.03	.75**	---	---
9. STEM Intentions	-.30**	.47**	.09*	.09	-.04	-.05	.52**	.57**	---
10. Academic Achievement	.08	<.01	.03	.05	.05	.07	-.14**	-.11*	-.04

Note. Female was entered as "1," males as "0"; STEM tracking coded as 1, all other tracks coded as 0; higher IQ Attitude scores indicate stronger beliefs in intelligence as malleable; higher Stereotype Disbelief scores indicate stronger disagreement with stereotypes; *p <.05, ** p <.01.

Hypothesis One

H_1: At posttest, participants who receive the treatment will have statistically higher IQ attitude scores than participants in the comparison and control groups.

As depicted in Table 10, treatment group mean IQ attitude scores were highest, consistent with this hypothesis, followed by comparison group mean IQ attitude scores. A one-way analysis of variance was conducted to evaluate the relationship between condition group assignment (treatment, comparison, and control) and IQ Attitude as measured by the three-item Index of Malleability scale (Dweck, Chiu, & Hong, 1995). The ANOVA was significant, $F(2, 485) = 12.71$, $p < .001$. Group assignment accounted for 5% of the variance of the dependent variable, as measured by partial eta squared.

Follow-up tests were conducted to evaluate pairwise differences among the means of the dependent variable by group condition. Evaluation of scatter plots and

Levene's Test of Equality of Error variance, $F(2, 485) = .17$ $p = .85$, indicated that the variances among the condition groups were not significantly different, so the Tukey post hoc procedure was used to examine pairwise differences, which assumes equal variances. Using this post hoc procedure, the treatment group IQ attitude scores were found to be significantly higher than both the comparison and control groups, with *p* levels less than .001 for both pairwise comparisons. IQ attitude scores on the comparison and control groups were almost identical, $p = .998$. These results provide support for my first hypothesis.

Next, analysis of variance was conducted post-hoc with the data split by gender to examine the effect of the intervention on IQ Attitude separately for men and women. Group condition accounted for 7.3% of the variance of the female participants' IQ attitude sores and 2.5% of the variance of the male participants' IQ attitude scores. Using the Tukey post hoc procedure for comparing pairwise differences for the female participants, the mean difference between treatment and comparison (.60) and between the treatment and control (.66) were both significant ($p < .001$). The mean difference between the comparison and control (.06) was not significant ($p = .91$). Mean IQ Attitude scores for the group of male participants were highest for those in the treatment group (see Table 10), but the ANOVA examining the effect of group condition on IQ Attitude scores for this smaller group of participants was not statistically significant, $F(2, 188) = 2.45$, $p = .09$. Next, I conducted an analysis of covariance (ANCOVA) on the effect of group condition on IQ attitudes with gender as a covariate to assess whether or not gender moderates the effect of group condition on IQ attitude. No significant interaction effect was found between group condition and gender on IQ attitude scores, $F(2, 482) =$

.8, p = .45, η = .003. While the treatment significantly impacted scores overall, the effect was not powerful enough to be detected in this small subset of men.

Hypothesis Two

H_2: At posttest, participants who receive the treatment will show statistically stronger stereotype disbelief than participants in the comparison and control groups.

Overall, mean stereotype disbelief scores as measured by Cutting's (2010) 6-item "Belief Scale" were highest for the participants in the treatment group, consistent with this hypothesis, followed by the control group (see Table 10). The ANOVA used to evaluate the relationship between condition group assignment and mean scores on stereotype disbelief was significant, $F(2, 485) = 3.13$, $p = .045$. However, the strength of the relationship between group assignment and beliefs in intelligence was small, with group assignment accounting for 1.3% of the variance as measured by partial eta squared.

Follow-up tests were conducted to evaluate pairwise differences among the means. Evaluation of scatter plots and Levene's Test of Equality of Error variance, $F(2, 485) = .66$, $p = .52$, indicated that the variances among the condition groups were not significantly different, so I proceeded with the Tukey post hoc procedure. The biggest pairwise difference was found between the treatment group and comparison group (.32, p = .047) followed by the treatment and control group (.27, p = .13). The difference between the comparison and control group was smallest (-.05, p = .92). Therefore, the treatment group's average stereotype disbelief score was significantly higher than the comparison group's, but not significantly higher than the control group's. These results provide mixed support for this hypothesis, indicating that the treatment was not as effective at demystifying gender-math stereotypes as it was intended to be.

Next, I split the data according to gender and reran the ANOVA examining the effect of group condition on stereotype disbelief scores in order to look at the effects separately for the group of women and men. The effect sizes were similar for the group of female participants, $F(2, 294) = 2.73$, $p = .07$, $\eta = .018$, and male participants, $F(2, 188) = 1.18$, $p = .31$, $\eta = .012$. Neither ANOVA was statistically significant due to the small effect sizes and decrease in power. These post-hoc assessments provide further evidence that the treatment did not adequately increase stereotype disbelief for the female or male participants.

Hypothesis Three

H_3: At posttest, participants who receive the treatment will report significantly higher STEM course and career self-efficacy than participants in the comparison and control groups.

As depicted in Table 10, control group participants had the highest average scores on STEM course and career self-efficacy, as measured by the Math/Science Course Self-Efficacy Scale and the Math/Science Occupational Self-Efficacy Scale (Cooper & Robinson, 1991), followed by the comparison group participants, contrary to this hypothesis (see Table 10). However, these differences were not statistically significant per the results of an ANOVA used to examine the effect of group condition on STEM course self-efficacy scores, $F\ (2, 486) = 1.31$, $p = .27$, $\eta = .005$, and the results of an

ANOVA used to examine the effect of group condition on STEM career self-efficacy scores, F (2, 448) = 2.38, p = .09, η = .011.

Post-hoc, I further analyzed these results via ANCOVA with major tracking (STEM tracked versus not STEM tracked), career decidedness, and major decidedness scores as covariates: perhaps students who had their minds made up about whether or not to go into STEM prior to the intervention would be less impacted by the intervention. A main effect was found for STEM tracking on STEM course self-efficacy, F (2, 480) = 86.50, p < .001, η= .153, but not major decidedness, F (1, 480) = .135, p = .714, η <.001, or career decidedness, F (1, 480) = .002, p = .965, η < .001. A main effect was also found for STEM tracking on STEM career self-efficacy, F (1, 442) = 78.42, p < .001, η= .15, but not for major decidedness scores, F (1, 442) = .50, p = .478, η <.001, or career decidedness scores, F (1, 442) = .239, p = .625, η = .001. Controlling for STEM tracking and major and career decidedness with ANCOVA produced similar results: group assignment did not significantly affect STEM course self-efficacy scores, F (2, 482) = 1.89, p = .15, η = .01, or STEM career self-efficacy scores, F (2, 442) = 1.98, p = .14, η = .01.

Next, I split the data by gender and reran the analyses. The effect of group condition on STEM course self-efficacy was not significant for the separate group of female participants, both without controlling for STEM Track, F (2, 295) = .25, p = .78, η = .002, and when controlling for STEM Track, F(1, 295) = .458, p = .633, η = .003. The effect of group condition on women's STEM career self-efficacy was also not statistically significant without controlling for STEM track, F(2, 271) = 2.18, p = .12, η = .016, as well as when controlling for STEM track, F (2, 271) = 2.01, p = .136, η = .015. For the group of male participants, the effect of group condition on STEM course self-efficacy, *F* (2, 188) = 1.28, *p* = .28, η = .013, and STEM career self-efficacy, *F*(2, 177) = .539, *p* = .584, η = .006, was not significant without controlling for STEM Track. When controlling for STEM track, the ANCOVA examining the effect of group condition on STEM course self-efficacy, *F*(2, 188) = 1.92, *p* = .149, η = .020, and STEM career self-efficacy, *F* = .836; *p* = .435, η = .009, were also both insignificant.

In summary, these results fail to support this third hypothesis: the treatment condition did not significantly affect STEM course or career self-efficacy for men or women, even when controlling for possible effects of their preexisting degree of certainty about their major and career goals and their general interest-area academic tracks.

Hypothesis Four

H_4: At posttest, participants who receive the treatment will report significantly stronger intentions to pursue STEM than participants in the comparison and control groups.

Contrary to this hypothesis, mean scores on STEM intentions, as measured by participants' average scores on Toker's (2010) 12-item "Intent to Persist in STEM" measure, were highest for the control group, followed by the comparison group. However, these differences were statistically insignificant per ANOVA results, *F*(2, 486) = .33, *p* = .72, η = .001.

As with my third hypothesis, I explored the results further using an ANCOVA with STEM track, major decidedness, and career decidedness as covariates. Again, results indicated a significant main effect of STEM tracking on STEM intentions, *F*(1,

482) = 135.91, $p < .001$, $\eta = .22$, but not of major decidedness, F(1, 482) = .115, $p = .735$, $\eta < .001$, or career decidedness, $F(1, 482) = 1.48$, $p = .224$, $\eta = .003$. Results of the ANCOVA looking at the effect of group condition on STEM intentions while controlling for STEM tracking, major decidedness, and career decidedness was not significant, F (2, 482) = .55 $p = .577$, $\eta = .002$.

ANOVAs conducted on the data split by gender separately were non-significant for the data of the female participants without controlling for STEM track, $F(2, 295) = .19$, $p = .83$, $\eta = .001$, and with STEM track as a covariate, $F(2, 294) = .17$, $p = .85$, $\eta = .001$. For the data of the male participants, the effect on group condition on STEM intentions was also not significant without controlling for STEM track, $F(2, 188) = .13$, $p = .88$, $\eta = .001$, as well as with controlling for STEM track, $F(2, 187) = .47$, $p = .63$, $\eta = .005$.

In summary, these results fail to support this fourth hypothesis: the treatment condition did not significantly affect STEM intentions for men or women, even when controlling for possible effects of their preexisting degree of certainty about their major and career goals and their general interest-area academic tracks.

General interest areas. Table 12 presents the descriptive results of participants' intent to pursue general interest areas, as categorized by Arizona State University. Across group condition, the most popular interest area for female participants was "biological sciences, health and wellness," followed by "communication and media," followed by "social science." Across group conditions, "engineering and technology" was the most popular general interest area for males, followed by "biological sciences, health and wellness." "Business, management and economics" was the third most popular interest area.

Table 12
Percentages of Participants Indicating Intent to Pursue General Interest Areas by Gender and Group Condition.*

Interest Area	Treatment	Comparison	Control	Total
Architecture, Construction & Design	1 (2)	3 (1)	1 (5)	2 (3)
Artistic Expression & Performance	2 (2)	6 (6)	9 (5)	5 (4)
Biological Sciences, Health & Wellness	31 (23)	35 (23)	29 (19)	32 (22)
Business, Management & Economics	7 (16)	11 (19)	14 (20)	11 (18)
Communication & Media	20 (9)	18 (4)	14 (9)	17 (7)
Computing & Mathematics	1 (5)	0 (3)	2 (2)	1 (3)
Education & Teaching	12 (4)	5 (1)	3 (3)	6 (3)
Engineering & Technology	6 (25)	6 (29)	3 (27)	5 (27)
Environmental Issues & Physical Sciences	1 (5)	2 (1)	0 (1)	1 (3)
Interdisciplinary Studies	0 (0)	1 (1)	0 (3)	<1 (2)
Languages & Cultures	0 (0)	1 (1)	1 (0)	1 (1)
Law & Justice	8 (7)	4 (6)	5 (1)	6 (5)
Social Science	11 (2)	11 (3)	18 (3)	13 (3)
Policies & Issues	0 (0)	0 (1)	0 (0)	0 (<1)

Note. Totals of percentages are not 100 for every characteristic due to rounding. * Percentages of female respondents noted outside parentheses, males within. Participants received the following prompt: "As of today, please select the category of discipline that you are most likely to pursue."

Specific major and career intentions. Table 13 below presents a summary of categorized open-ended major and career intentions participant responses. Health-related fields and "other non-S & E" fields were most popular for both male and female participants. "Other non-S& E" fields include communications, journalism, pre-law, criminal justice, fitness studies, library science, public administration/affairs, and any other field not related to science and engineering. The field of engineering was also popular among male participants.

Table 13

Summary of Categorized Responses to Open-Ended Major and Career Intentions Items by Gender and Group Condition*

	Treatment		Comparison		Control		Total	
Discipline	Major	Career	Major	Career	Major	Career	Major	Career
Science and Engineering								
Life and related sciences	7 (2)	2 (2)	6 (4)	7 (3)	9 (3)	4 (5)	7 (3)	5 (3)
Computer and mathematical sciences	2 (9)	0 (5)	0 (4)	0 (2)	4 (5)	1 (3)	2 (6)	<1 (4)
Physical and related sciences	1 (5)	0 (2)	0 (3)	0 (0)	1 (3)	0 (2)	<1 (4)	0 (1)
Social and related sciences	13 (2)	12 (4)	7 (7)	5 (3)	12 (9)	5 (0)	10 (6)	7 (2)
Engineering	2 (20)	5 (14)	5 (23)	5 (21)	2 (14)	2 (15)	<1 (19)	4 (17)
Science and Engineering related								
Health-related fields	21 (18)	23 (20)	26 (13)	32 (17)	18 (12)	26 (15)	22 (14)	27 (17)
Science and mathematics teacher ed	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	<1 (0)
Technology and technical fields	0 (2)	0 (5)	0 (0)	0 (0)	0 (9)	2 (11)	0 (4)	<1 (5)
Other S & E-related fields	5 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	<1 (0)	0 (0)
Non-S&E								
Arts and Humanities	4 (7)	7 (7)	5 (0)	4 (7)	12 (8)	11 (11)	7 (5)	7 (8)
Management & administration fields	5 (7)	6 (9)	7 (0)	9 (19)	11 (9)	11 (0)	7 (5)	9 (9)
Education	8 (5)	13 (5)	6 (4)	7 (6)	4 (2)	5 (5)	6 (4)	8 (3)
Sales and marketing fields	1 (5)	2 (5)	5 (3)	3 (1)	2 (3)	2 (3)	3 (2)	2 (3)
Social service and related fields	2 (0)	0 (0)	4 (0)	4 (0)	1 (0)	6 (2)	2 (0)	3 (<1)
Other non S&E** fields	25 (14)	20 (20)	24 (14)	22 (13)	24 (17)	20 (17)	24 (15)	21 (16)
Undecided	4 (1)	7 (2)	0 (3)	2 (7)	1 (3)	3 (5)	2 (3)	4 (5)

Note. Numbers indicate the percentages (rounded) of students expressing intent to major or pursue a career in a particular area. * Percentages of female respondents noted outside parentheses, males within. ** S & E = Science and Engineering. Participants were asked "As of today, please type in the major that you are most likely to pursue" followed by "Please write your current career aspiration (or the career you are most likely to pursue in the future)"

Intentions to take math courses. As seen in Table 14, a large percentage of both female and male students indicated interest in taking college mathematics, college algebra, and/or pre-calculus. This suggests that the students in this sample had perhaps not yet completed the prerequisites for college-level coursework upon matriculating the university. Overall, the proportion of men indicating interest in taking a calculus level math course or higher appeared to be high compared to the proportion of women interested in taking a calculus or higher math course. This is consistent with Ma and Johnson's (2008) theory that college-level coursework like calculus is a critical filter for women pursuing STEM fields because women are less likely to take the higher-level math courses needed to open doors to STEM career pathways.

Table 14
Percentages of Participants Indicating Intent to Take Specific Math Courses by Gender and Group Condition*

Course	Treatment	Comparison	Control	Total
College mathematics	32 (46)	52 (36)	47 (35)	44 (39)
College algebra (MA)	40 (45)	46 (26)	36 (44)	41 (34)
Pre-calculus	38 (59)	48 (31)	30 (40)	39 (42)
Brief calculus	30 (40)	20 (30)	18 (25)	23 (29)
Calculus 1	30 (52)	27 (49)	19 (43)	26 (48)
Calculus 2	17 (36)	15 (37)	14 (39)	15 (37)
Calculus 3	13 (25)	13 (30)	10 (29)	12 (28)
Differential equations	5 (9)	2 (14)	3 (14)	3 (13)
Linear algebra	4 (7)	2 (10)	3 (11)	3 (9)
Math for business analysis	10 (20)	17 (19)	16 (20)	14 (19)
I don't know	28 (29)	29 (23)	31 (29)	30 (27)

Note. Percentages are rounded. * Percentages of female respondents noted outside parentheses, males within. Participants received the following prompt: "Of the courses listed below, please put a check by those you plan to take in college." The item allowed for multiple responses.

Hypothesis Five

H_5: The impact of the treatment on posttest scores of STEM course and career self-efficacy will be moderated by gender.

As depicted in Table 10, participants' gender was found to be significantly related to STEM course and career self-efficacy scores, providing evidence that gender could serve as a possible moderator between the effects of the treatment group on STEM course and career self-efficacy scores. A weaker than expected relationship between an independent variable and a dependent variable (such as that found between group condition and STEM self-efficacy) could be due to the effect of a moderator (e.g., Frazier, Tix, & Barron, 2004; Wu and Zumbu, 2008). According to Baron and Kenny (1986) as cited in Wu and Zumbu (2008), a two way ANOVA is the best way to test for moderator effects when the proposed moderator is categorical. A two-way ANOVA with gender and group condition as independent variables and STEM course self-efficacy as the dependent variable indicated a significant main effect of gender on STEM course self-efficacy, $F(2, 483) = 30.44$, $p < .001$, $\eta = .059$, but not a significant interaction effect between gender and group condition on STEM course self-efficacy scores, $F(2, 483) = .33$, $p = .72$, $\eta = .001$. A two-way ANOVA with gender and group condition as independent variables and STEM career self-efficacy as the dependent variable indicated a significant main effect of gender on STEM career self-efficacy, $F(2, 445) = 38.04$, $p < .001$, $\eta = .079$, but not a significant interaction effect between gender and group condition on STEM career self-efficacy scores, $F(2, 445) = .79$, $p = .72$, $\eta = .004$. Overall, women reported lower scores on STEM course and career self-efficacy compared to men (see Table 10). These results fail to support my fifth hypothesis but provide evidence of a relationship of a moderate strength between gender and STEM self-efficacy, as expected.

Hypothesis Six

H_6: The impact of the treatment on posttest scores of intentions to pursue STEM disciplines will be moderated by gender.

A two-way analysis of variance indicated a significant main effect of gender on STEM intentions, $F(1, 483) = 46.14$, $p < .001$, $\eta = .087$, but not a significant interaction between group condition and gender on STEM intentions, $F(2, 483) = .12$, $p = .89$, $\eta < .001$. Overall, women reported significantly lower scores on intentions to pursue STEM compared to men (see Table 10). These results fail to support my sixth hypothesis regarding gender as a moderator but provide evidence of a relationship of a moderate strength between gender and STEM Intentions.

Hypothesis Seven

H_7: Participants who receive the treatment will show statistically stronger academic performance, as measured by semester GPA, compared to students in the comparison and control groups.

Not all participants gave permission for the researcher to access their end of the fall semester GPA, resulting in a smaller sample size ($n = 408$) and, therefore, less power. The treatment group participants' average GPAs were the highest, as hypothesized, followed by the comparison group participants'. Analysis of variance indicated that group condition had a statistically significant ($F(2, 405) = 3.2$, $p = .04$) but small ($\eta = .015$) effect on the variance of GPAs.

Follow-up tests were conducted to evaluate pairwise differences among the means of the dependent variable by group condition. Evaluation of scatter plots and Levene's Test of Equality of Error variance, $F(2, 405) = .17$ $p = .04$, indicated that the variances among the condition groups were significantly different, so I chose to use the Dunnette's C post-hoc procedure, which does not assume equal variances. Using this post hoc test, the treatment group's average GPA was significantly higher than the control group's average GPA. Pairwise comparisons between the treatment and comparison group and between the comparison and control group were not significantly different as indicated by the results of Dunnette's C post-hoc procedure. Table 15 depicts the 95% confidence intervals of pairwise differences between groups on average GPA. Overall, these results partially support my seventh hypothesis: the treatment appeared to have a significant, positive effect on GPA compared to no intervention but not compared to the comparison intervention.

Table 15
95% Confidence Intervals of Pairwise Differences in Fall Semester GPA

Group Condition	n	M	SD	Treatment	Comparison
Treatment	126	3.10	.73		
Comparison	144	3.03	.81	-.29 to .15	
Control	138	2.86	.91	-.48 to -.01*	-.42 to .07

Note. An asterisk indicates that the 95% confidence interval does not contain zero, and therefore the difference in means is significant at the .05 significance using the Dunnett's C procedure.

Hypothesis Eight

H_8: Participant scores on IQ attitude and stereotype disbelief will be positively related to each other as well as to STEM course and career self-efficacy, and indirectly, positively related to STEM intentions via STEM course and career self-efficacy, as modeled in Figure 1.

Path analyses using Mplus (Version 7) (Muthén & Muthén, 2012) statistical analysis software with robust maximum-likelihood (MLR) estimation procedures were run to determine the overall fit of the proposed path model in Figure 1, which pictorially represents hypothesis eight**,** and to examine the strengths and direction of the relationships between the outcome variables in the model. A Monte Carlo bootstrapping procedure (MacKinnon, Lockwood, & Williams, 2004) was used to estimate the confidence intervals for the parameter estimates of the indirect effects.

First, fit statistics, presented in Table 16, were examined to assess how well the data fit the hypothesized model. The chi-square statistic (χ^2) was used to test the hypothesis that the measurement model fit the observed data perfectly. A chi-square value of zero indicates that the proposed model perfectly fits the data. Smaller chi-square values, which result in larger associated *p* values assuming constant degrees of freedom, therefore provide supporting evidence for an acceptable measurement model. As depicted in Table 16, the chi-square value was small yet still significant, χ^2 (2) = 8.89, p = .012. Therefore, the "exact fit" hypothesis was rejected. Many researchers choose to ignore the results of this statistic when their sample size is over 200, as it is usually significant with a large sample size (Kline, 2011). However, Kline (2011) recommends rejecting the model as an exact fit upon a failed chi square test for any size sample. The remaining fit statistics in Table 16 can be understood as testing the "acceptable fit" hypothesis. First, the Bentler Comparative Fit Index (CFI), (Bentler, 1990) indicates the relative improvement in fit of the researcher's model compared to a statistical baseline model (which assumes zero population covariances among the observed variables). Values range from 0 to 1, with values of 1 indicating the best fit and with values .90 or higher generally considered to be an indicator of acceptable fit (Hu & Bentler, 1999). The Tucker Lewis Index (TLI) (also known as the Non Normed Fit Index) is highly correlated with the CFI but corrects for model complexity, thus favoring simpler models. Like the CFI, TLI estimates of .90 and above are viewed as signifying good fit. The CFI estimate of .986 and TLI estimate of .937 for the hypothesized model are both well within the range considered to indicate acceptable fit. The Steiger-Lind root mean square error of approximation (RMSEA), (Steiger, 1990), a fit statistic also favoring simpler models, includes a 90% confidence interval. Values of 0 indicate the best fit, values less than or equal to .05 are considered to indicate a close fit, and values greater than or equal to .10 are considered to indicate a poor fit (Browne & Cudeck, 1993). The RMSEA estimate of .084 falls above what is considered to be in the "acceptable" range and below what is considered in the "bad" range. The standardized root mean square residual (SRMR) statistic is the square root of the discrepancy between the sample covariance matrix and the model covariance matrix. This statistic ranges from 0 to 1; a value of .08 or less is considered to indicate acceptable fit. Therefore, the SRMR estimate of .028 for the hypothesized model also indicates acceptable fit. Kline (2011) recommends viewing approximate fit indices as qualitative or descriptive information about model fit. Overall, these fit statistics are consistent with the “acceptable fit” hypothesis.

Table 16

Model Fit Indices (N = 489)

Model	χ^2(df)	*p*	CFI	TLI	RMSEA (90%CI)	SRMR
Hypothesized	8.89(2)	.012	.986	.937	.084 (.034-.144)	.028
Female Group (*N* = 298)	4.27(2)	.119	.992	.963	.062 (.000-.144)	.022
Male Group (*N* = 191)	7.09(2)	.029	.973	.877	.115 (.032-.213)	.036
Gender Constrained	22.69(12)	.030	.977	.966	.060 (.018-.098)	.053
Gender Unconstrained	13.87(8)	.085	.987	.972	.055 (.000-.102)	.038
Gender Specific (Final)	15.23(12)	.229	.993	.990	.033 (.000-.077)	.040

Note. CFI = Comparative Fit Index, TLI = Tucker Lewis Index, RMSEA = Steiger-Lind root mean square error of approximation, SRMR = standardized root mean square residual.

Standardized and unstandardized parameter estimates were examined to assess the strength and direction of individual paths of the model (see Figure 3). Consistent with what has already been well established in the literature, STEM course and career self-efficacy and STEM intentions were positively related. STEM course self-efficacy and STEM career self-efficacy were strongly related, $r = .75$, $p < .001$. Controlling for STEM career self-efficacy, about 4% (the squared standardized loading) of the observed variation in STEM intention was explained by STEM course self-efficacy, $\beta = .21$, z = 3.69, $p < .001$. Controlling for STEM course self-efficacy, the standardized path coefficient between STEM career self-efficacy and STEM intentions was also significant ($\beta = .40$, z = 3.69, $p < .001$), indicating that 16% of the observed variation in STEM intentions was explained by STEM career self-efficacy.

As hypothesized, a significant, positive relationship of moderate strength was observed between IQ attitude and stereotype disbelief, $r = .36$, $p < .001$. This suggests that participants who tended to believe that intelligence is malleable also tended to disagree with gender stereotypes about math abilities. The relationship between IQ attitude and STEM course self-efficacy, controlling for stereotype disbelief, was also significant, $\beta = .10$, z = 1.99, $p < .046$. This result is consistent with the hypothesis that participants with stronger beliefs in malleable intelligence would have stronger STEM self-efficacy. However, these results indicate that only 1% of the observed variation in STEM course self-efficacy was explained by IQ attitude when controlling for stereotype disbelief. The 95% confidence intervals of the estimate of the effect of IQ attitude on STEM intentions via STEM course efficacy [0.0003, 0.0708] did not contain zero, and is therefore statistically significant, $p <.05$. None of the remaining direct and indirect effects implied by the model were significant. These results provide mixed support for hypothesis eight.

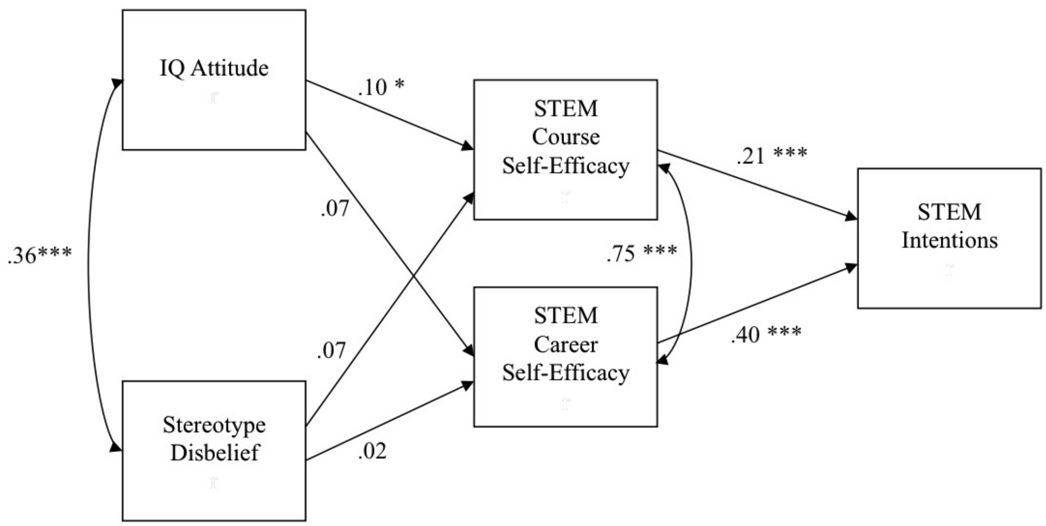


Figure 3. Standardized parameter estimates of the hypothesized path model. *Significant at the .05 level. ***Significant at the .001 level.

Model fit for women. Next, I tested the hypothesized model separately for female and male participants to examine how model fit might vary by gender. As can be seen in the row labeled "Female Group" in Table 16, the hypothesized model appeared to fit the group of female participants well overall: the "exact fit" (chi-square) hypothesis was not rejected and all other fit statistics reflected acceptable fit. Examination of path coefficients (see Figure 4) indicates that, for women, IQ attitude, controlling for stereotype disbelief, did not significantly account for the variance of STEM self-efficacy. However, the paths from stereotype disbelief to STEM course and career self-efficacy, controlling for IQ attitude, were both significant.

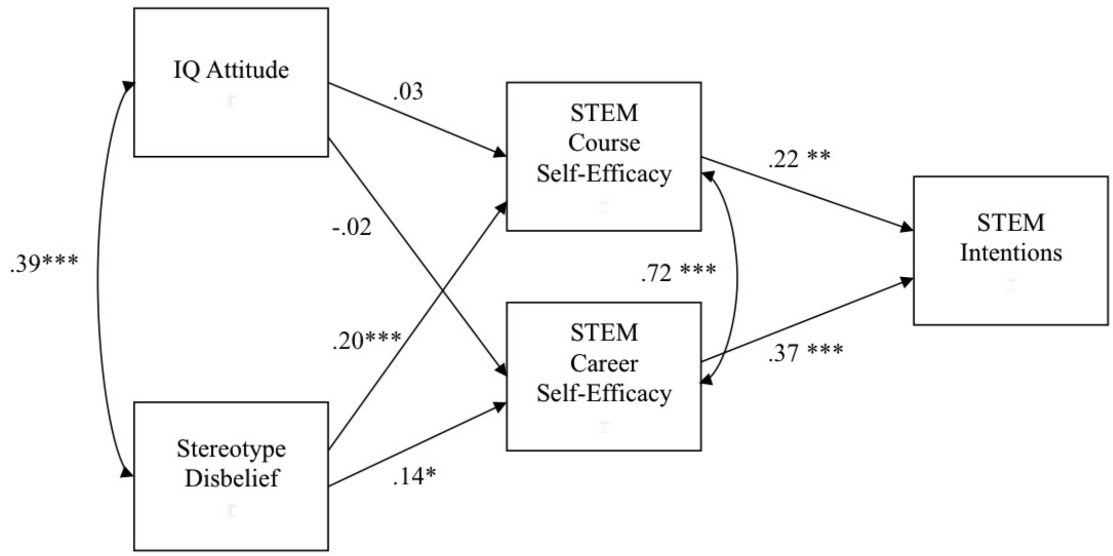


Figure 4. Standardized parameter estimates of the hypothesized path model, analyzed separately for the group of female participants. *Significant at the .05 level.** Significant at the .01 level. ***Significant at the .001 level.

Model fit for men. The model did not appear to be a good fit for the group of male participants as reflected by a significant chi square statistic and poor TFI and RMSEA results (see the "Male Group" row in Table 16). Although the hypothesized model was overall a poor fit for the data of the group of male participants, all direct paths implied by the model were statistically significant, except those from STEM course self-efficacy to STEM intentions, controlling for STEM career self-efficacy, and those from stereotype disbelief to STEM course and career self-efficacy, controlling for IQ attitude (see Figure 5).

Taken together, these results suggest that IQ Attitude may be directly related to STEM self-efficacy for men but not for women, and that stereotype disbelief may be directly related to STEM self-efficacy for women but not for men.

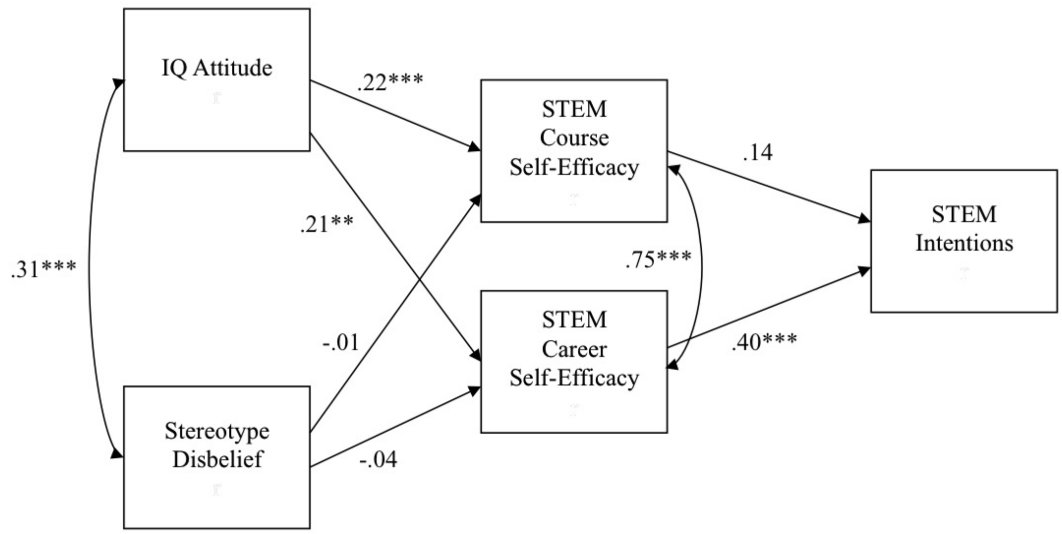


Figure 5. Standardized parameter estimates of the hypothesized path model, analyzed separately for the group of male participants.** Significant at the .01 level. ***Significant at the .001 level.

Multiple group model comparisons. In order to formally test whether and how the paths from IQ attitude and stereotype disbelief to STEM self-efficacy are different for male and female participants, a multiple group model was estimated. A multiple group path analysis allows for assessing model fit for different groups simultaneously but separately (Kline, 2005). The presence of a moderator effect can be assessed by comparing the fit of a multiple group model that constrains groups of interest to be equal on all paths to a multiple group model that allows these groups to vary on paths of interest. If the less constrained model shows a significant improvement of model fit compared to the more constrained model, the moderator hypothesis is supported. Therefore, a path analysis was run on a model that constrained all paths to be equal across groups ("Gender Constrained") and compared to the fit of a model in which the four paths from IQ attitude and stereotype disbelief to STEM course and career self-efficacy were allowed to vary for the group of women and men in the sample ("Gender Unconstrained"). Overall, fit statistics for the unconstrained model were superior (see Table 16). The Satorra-Bentler scaled chi-square difference (Satorra, 2000) between the constrained and unconstrained models was not statistically significant, χ^2 (4) = 8.749, p = .068. However, the CFI change of .01 was just at the threshold recommended by Cheung and Rensvold (2002) as a potential "cut off value" for choosing one model over another. Therefore, the "Gender Unconstrained" model was retained.

Further assessment was needed to determine whether or not the paths from IQ attitude to STEM course and career self-efficacy for women and the paths from stereotype disbelief to STEM course and career self-efficacy for men were unnecessary and could be dropped from the model. To do this, I compared the "Gender Unconstrained" model to a "Gender Specific" model. In the "Gender Specific" model, the paths from IQ attitude to STEM course and career self-efficacy were dropped (fixed to zero) for the group of female participants (but retained for the male participants) and the paths from stereotype disbelief to STEM course and career self-efficacy were dropped for male participants (but retained for the female participants). The Satorra-Bentler scaled chi-square difference test (Satorra, 2000) between these models indicated that removing these parameters did not significantly decrease model fit, χ^2 (4) = 1.582, p = .812, CFI change = -.006. This implies that the paths are not necessary in the model. In fact, most of the fit statistics were superior in the "Gender Specific" model (see Table 16). Therefore, I retained the most parsimonious model, the "Gender Specific" model. The chi-square value of this model was not significant, indicating that the "exact fit hypothesis" was not rejected, $\chi^2(12) = 15.23$, $p = .229$. The CFI, TLI, RMSEA, and SRMR estimates of .993, .990, .033, .040, respectively, are all indicative of good fit. The standardized and unstandardized parameter estimates of this model for the group of female participants and the group of male students are depicted in Figure 6. In this final model, all paths are statistically significant. IQ attitude is strongly related to stereotype disbelief. Stereotype disbelief is directly related to STEM self-efficacy for women but not for men. IQ attitude is directly related to STEM self-efficacy for men but not for women. Course and career self-efficacy are strongly related to each other and to STEM intentions. For the group of men, the 95% confidence intervals of the estimates of the indirect effect of IQ attitude on STEM intentions via STEM course self-efficacy [.0156, .1136] and via STEM career self-efficacy [.0373, .1835] did not contain zero, and are therefore statistically significant, $p < .05$. For the group of women, the 95% confidence intervals of the estimates of the effect of stereotype disbelief on STEM intentions via STEM course self-efficacy [.0147, .1125] and STEM career self-efficacy [.0075, .1219] did not contain zero, and are therefore also statistically significant, $p < .05$.

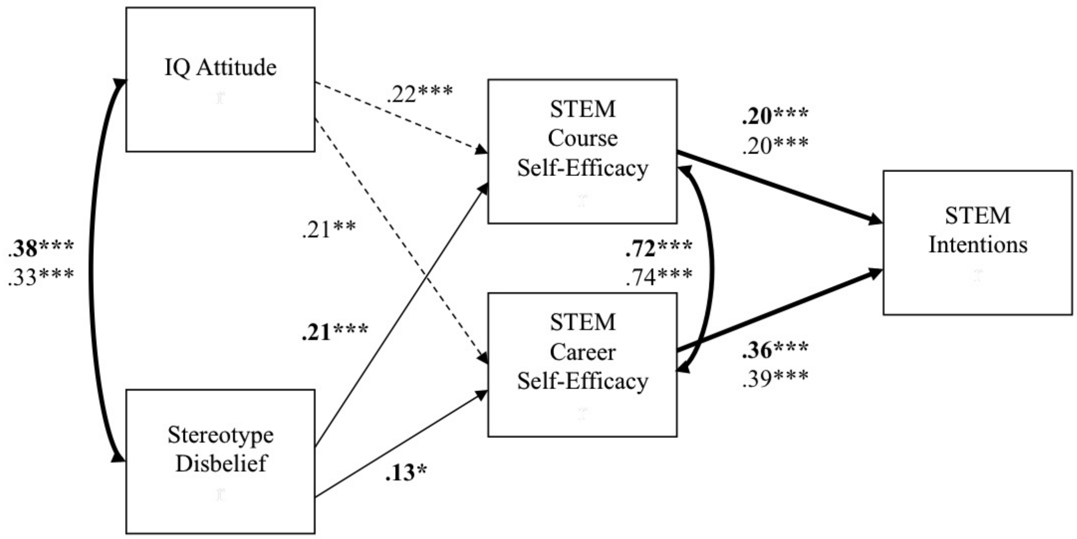


Figure 6. Standardized parameter estimates of the final path model. Bold arrows represent paths for both female and male participants. Dashed arrows indicated paths dropped for women but kept for men. Solid, non-bolded arrows represent paths dropped for men but kept for women. Bolded numbers represent path estimates for women; non bolded numbers represent path estimates for men. *Significant at the .05 level. **Significant at the .01 level. ***Significant at the .001 level.

Chapter 4: Discussion

Undeclared undergraduates participated in an experimental study designed to explore the impact of an Internet-delivered "growth mindset" training on indicators of women's persistence in science, engineering, technology, and mathematics (“STEM”) disciplines. This intervention was hypothesized to increase STEM self-efficacy and intentions to pursue STEM by strengthening beliefs in intelligence as malleable ("IQ attitude") and discrediting gender-math stereotypes (strengthening "stereotype disbelief"). Hypothesized relationships between these outcome variables were specified in a path model: IQ attitude and stereotype disbelief were hypothesized to be related to each other; both were hypothesized to be directly related to STEM course and career self-efficacy and indirectly related to STEM intentions via STEM course and career self-efficacy. The intervention was also hypothesized to bolster academic achievement.

The intervention I created was based on the attitude change techniques used by Aronson, Fried, and Good (2002) and Dweck's "growth mindset" training techniques (Dweck, 1986, 1999; Dweck & Leggett, 1988; Hong, Chiu, & Dweck, 1995). After completing a demographic questionnaire, the undeclared, first-year college student participants were randomly assigned to treatment, comparison, and control groups. Control group participants received only the outcome questionnaire. Both treatment and comparison group participants were led to believe they were participating in a pilot study of an online mentoring program for academically at-risk middle school students, and that the tutorial they were to receive would help them be effective mentors. Treatment group participants received “growth mindset” training and comparison group participants received a tutorial on persuasive writing techniques. After receiving their respective trainings, both treatment and comparison group participants were assigned to a fabricated "mentee profile" and were asked to write a personal, inspirational letter to their assigned mentee utilizing the knowledge they gained via the training. This letter writing assignment was intended to exploit the saying-is-believing attitude change principle. After submitting the letter, treatment and comparison group participants completed an outcome questionnaire with items assessing IQ attitude, stereotype disbelief, STEM course and career self-efficacy, and intentions to pursue STEM disciplines. The study was delivered through QuestionPro, an online survey service, and took place during the beginning of the fall semester of 2012. End-of-the-semester GPA data collected from the university registrar were used as indicators of academic achievement for consenting participants. I was also able to obtain students' GPAs from the university registrar instead of relying on self-report, which possibly resulted in a more accurate picture of the effects of the treatment intervention on academic achievement.

The ability to incorporate the study as a required assignment into a course required for the student population of interest at ASU was a major methodological advantage that resulted in a large sample with high retention. Another advantage was the ability to program forced-answer demographic and outcome questionnaire items into the study. As discussed in Chapter 2, this strategy was approved by IRB because the study was considered part of the course curriculum and because the course syllabus stated that classroom data may be used for research purposes. Another advantage of the study was the ability to randomly assign students individually instead of by classroom because the intervention was delivered online as a homework assignment. This helped to avoid confounding factors associated with assignment by classroom, such as the effects of the instructor, classroom climate, and time of day. Furthermore, including a comparison condition in addition to a control condition allowed for more sophisticated analyses of the effects of the intervention. In particular, I was able to provide some supporting evidence that treatment effects were due to the growth mindset training and not entirely, if at all, to the possible effects of an inspirational writing exercise or of engaging in a purported mentoring activity.

Ultimately, 489 participants completed the study, and their data set was almost free of missing data. Treatment and comparison group participants appeared to participate actively in the interventions, as they tended to answer reading comprehension questions accurately and generally wrote lengthy letters. Only two participants indicated skepticism in the nature of the study, suggesting that the deception was effective overall.

Analyses of variance were used to assess the hypotheses that the treatment intervention would significantly increase participants' IQ attitude, stereotype disbelief, STEM course and career self-efficacy, and academic achievement. Results suggested that the treatment had a modest effect on IQ attitude, stereotype disbelief, and academic achievement but no effect on any other outcome variable. Results of path analysis overall supported the hypothesized model between variables, but a model with gender-specific paths from IQ attitude and stereotype disbelief to STEM course and career self-efficacy was found to be superior. In the remaining sections, I will discuss these inferential results as well as several key findings of the descriptive data analysis. I will also discuss study implications, strengths, and limitations and propose directions for further research.

Observations

The intervention had a small impact on IQ attitude and stereotype disbelief. Group condition (treatment, comparison, or control condition) was found to have a small but significant effect on both IQ attitude scores and stereotype disbelief scores. As hypothesized, posttest scores on IQ attitude were significantly higher for the treatment group participants compared to the IQ attitude scores of both the comparison group participants as well as the control group participants. This suggests that the treatment intervention had the intended effect of helping to convince students that intelligence is malleable and not entirely fixed. Posttest IQ attitude scores of the comparison group participants and control group participants were almost identical. This indicates that the pen pal letter writing exercise, in which students wrote an inspirational letter about overcoming academic challenges via hard work, did not impact IQ attitude alone: the "growth mindset" training appears to be the key to changing IQ attitude. The posttest stereotype disbelief scores of the treatment group were also highest, but only the pairwise comparison between treatment group scores and comparison group scores showed a statistically significant difference. Therefore, the effect of the intervention on decreasing endorsement of negative stereotypes about women's math abilities was not as powerful as expected.

There are several possible explanations for these modest results. One is that the training was not sufficiently extensive and elaborate. Aronson, Fried, and Good's (2002) participants received repeated exposure to the training over the course of a semester, which included video clips, whereas my treatment group participants received a brief, low-tech online tutorial that included only pictures and text. Results of a study by

Steffens, Jelenec, and Noack (2010) indicate that the presence of math-gender stereotypes can be detected as early as age 9, providing reason to believe that such attitudes may be deeply rooted and difficult to change. Another explanation is that the effects of the intervention on these attitudes and beliefs will grow as students are given opportunities to test and disprove their previously held assumptions. Yeager and Walton (2011) believe that brief psychological education interventions are equally if not more effective than longer, less stealthy interventions, and that the effects can be recursive and gain momentum over time. Such delayed effects of attitude persuasion attempts are known as "sleeper effects" (Hovland, Lumsdaine, & Sheffield, 1949). A final possibility is that the intervention was not as effective at increasing IQ attitude and stereotype disbelief because participants already tended to believe that intelligence is malleable and also already tended to disagree with math-gender stereotypes, as explained below.

Participants tended to hold "growth mindsets" toward the nature of intelligence. Average IQ attitude and stereotype disbelief scores were high for both men and women across group conditions, indicating that participants tended to disagree that intelligence is a fixed trait; they also tended to disagree with stereotypes about women's math abilities. One possibility is that a recent explosion of media attention about brain plasticity has already affected students' attitudes. For example, there are several heavily advertised "brain training" centers, such as Luminosity.com and Rosetta Stone's "Fit Brain," that claim to utilize the science of neuroplasticity to help users "grow" their brains. TED talks have covered topics on neuroplasticity, such as one called "Growing Evidence of Brain Plasticity" by neuroscientist Michael Merzenich. In fact, some university tutoring services have already been implementing "growth mindset" training as part of their workshop series (e.g., UC Davis's Student Success Services). Although participants were told that their responses would be kept anonymous, it is also possible that the "self-deception" form of social desirability bias (Paulhus, 1984, 1994) affected scores, and therefore the items did not capture participants' true attitudes. It may seem more socially acceptable to endorse progressive views about the nature of intelligence and gender stereotypes. Similarly, it is possible that the scores did not capture participants' implicit attitudes and beliefs. Implicit associations and explicit attitudes are separate constructs that must be assessed with different measures (Nosek et al., 2002). The correlation between scores on measures of implicit and explicit math-gender stereotypes have been found to be relatively weak (Cvencek, Meltzoff, & Greenwald, 2011). The items used in this study were developed to assess explicit attitudes.

The female participants in this study tended to report especially progressive attitudes about intelligence and stereotypes. This result is consistent with research by Hyde, Fennema, Ryan, Frost and Hopp (1990), who found that men reported stronger agreement with math-gender stereotypes. It makes sense that men would be quicker to endorse stereotypes that do not apply negatively to their gender. Again, it is also possible that scores did not accurately capture attitudes due to social desirability bias or because the items did not tap into implicit biases. Research by Nosek et al. (2002) suggests that implicit math-gender biases are present equally for both men and women. Including a measure of implicit math-gender stereotypes might have helped to provide a more detailed picture of the participants' math-gender associations.

Felder, Felder, Mauney, Hamrin, and Dietz (1995) found that women were more likely than men to attribute their success to effort, but they were also more likely to attribute their failures to lack of ability. If women are especially likely to hold growth mindsets, they should be attributing both success and failure to effort, according to growth mindset theory. It is also possible that women tend to deny that intelligence is fixed in the general population but still attribute their own failures to lack of ability due to unconscious internalized sexism. This possibility is consistent with Crosby's (1984) theory of the denial of personal disadvantage, in which women attribute gender inequalities to discrimination but tend to deny their personal disadvantages as women. The tendency for individuals to have different patterns of biases when making cognitive attributions about their own successes or failures compared to when observing the successes and failures of others is known as "actor-observer asymmetry" in the social psychology literature (see Malle, 2006 for review). Further research is needed to understand whether or not gender differences exist in attitudes about the nature of intelligence, and how this might relate to cognitive attributions about success or failure.

IQ attitude and stereotype disbelief are related. IQ attitude and stereotype disbelief were positively and significantly related as hypothesized. That is, participants who tended to believe that intelligence is a fixed trait were more likely to believe gender stereotypes about math abilities, and participants who believed that intelligence is malleable tended to disagree with gender stereotypes about math abilities. Further research is needed to understand the nature and cause of this relationship, but the finding is consistent with Dweck's (2008) assertion that "negative stereotypes about ability are fixed mindset beliefs" (p. 5). Adopting a growth mindset might simultaneously discredit stereotypes about abilities and inoculate women to the effects of negative stereotypes as Dweck (2008) suggests. If students are convinced that intelligence can be shaped with effort and is not entirely innate, it may become more difficult to believe that some groups are inherently more or less capable than others. Another possible explanation is that IQ attitude and stereotype disbelief are measuring the same construct. However, this explanation is not supported by my results: the correlation between IQ attitude and stereotype disbelief was of only moderate strength ($r = .36$).

Gender-specific relationships exist between variables. Results suggest that the nature of the relationships between IQ attitude, stereotype disbelief, STEM course and career self-efficacy, and STEM intentions are gender specific, according to the results of path analysis. Figure 7 presents the final model of the relationships between these variables.

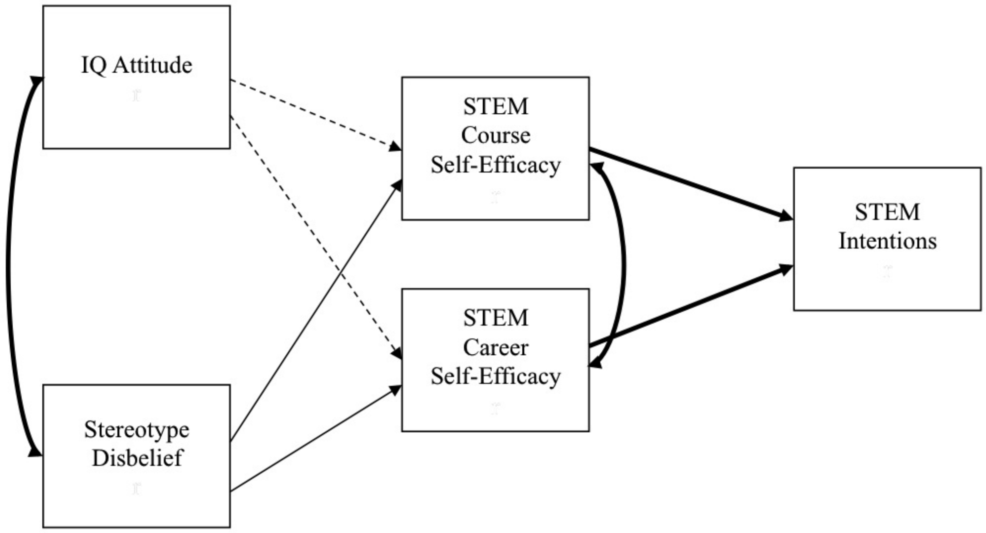


Figure 7. The final model representing the relationships between five factors. Bold arrows represent paths for both female and male participants. Dashed arrows indicated paths dropped for women but kept for men. Solid, non-bolded arrows represent paths dropped for men but kept for women. Bolded numbers represent path estimates for women; non bolded numbers represent path estimates for men. All relationships are positive.

The degree of the female participants' beliefs in math-gender stereotypes predicted their self-efficacy in STEM courses and careers, as was hypothesized. The indirect effects of stereotype disbelief on women's STEM intentions via STEM course and career self-efficacy were also significant. These results are consistent with those of Nosek et al., (2002) as explained in their article titled "Math = male, me = female, therefore math ≠ me." In their study, females were found to have implicit math-gender biases, which were related to stronger negative self-evaluations of math compared to men, especially for those female participants who identified strongly with being a woman. Cvencek, Meltzoff, and Greenwald (2011) have also found implicit math-gender stereotyping to be negatively related to girls' academic self-concept. My finding helps contribute to this literature by providing evidence that explicit math-gender stereotypes are related to general STEM self-efficacy. It also suggests that if my treatment intervention had a greater impact on stereotype disbelief, it might have also affected women's STEM self-efficacy as hoped. Of course, inferences about causality cannot be made based on these findings since my research design was not longitudinal. Another explanation for these results is that having poor STEM self-efficacy leads women to generalize about other women based on their own experiences.

The relationship between men's stereotype disbelief and their self-efficacy in STEM courses and careers was not significant. The items assessing stereotype disbelief referred to negative stereotypes about women's abilities in math and did not specifically reference men's abilities, so it seems logical that the scores on these items would not be significantly related to men's STEM self-efficacy. However, the lack of a statistically significant finding may also be attributable to a lack of power due to the relatively smaller sample size of the group of male participants. The (non-significant) relationship between stereotype disbelief and STEM self-efficacy was negative, meaning that the more men endorsed negative stereotypes about women's math abilities, the more confidence they held about their own abilities to be successful in STEM disciplines. This finding is consistent with the "stereotype lift" hypothesis, which suggests that in-group members' self-efficacy in a behavior of interest is elevated via negative comparisons of out-group members (Walton & Cohen, 2003; Shih, Pittinshy, & Ho, 2010). Further assessment with a larger sample of men is needed to assess whether or not stereotype disbelief and STEM self-efficacy are negatively related for men due to "stereotype lift."

IQ attitude and STEM self-efficacy were significantly related for the group of male participants as hypothesized. The more that men believed intelligence is a fixed trait, the less confidence they held in their abilities to do well in STEM courses and careers. The indirect relationship between IQ attitude and STEM intentions via STEM course and career self-efficacy was also significant. Therefore, while these results are correlational, not causational, they are consistent with my hypothesis that effective growth mindset training might help to increase engagement and persistence in STEM careers, at least for men. Given these results, it is possible that if my intervention had a more powerful effect on changing men's IQ attitudes, it might have also impacted their STEM self-efficacy scores.

However, contrary to my original hypothesis, IQ attitude did not appear to be significantly related to women's STEM self-efficacy when controlling for their beliefs about gender stereotypes. Therefore, it is possible that, for women, growth mindset training is only helpful as a STEM self-efficacy booster to the extent that it might simultaneously discredit math-gender stereotypes. These results suggest that perhaps a more effective growth mindset training for women would be one that focuses on women's abilities and potential in math and on discrediting math-gender stereotypes.

STEM self-efficacy and STEM intentions were strongly related. As hypothesized, STEM self-efficacy (both course and career) was strongly related to intentions to pursue STEM disciplines. This is consistent with the most important assumption of this study: that self-efficacy is a good predictor of engagement and persistence in STEM career pathways. A large body of research reviewed in Chapter 1 has shown self-efficacy to influence goal-related choices, motivations for behaviors, career interest development, and persistence (e.g. Bandura, 1997; Bandura & Locke, 2003; Pajares, 2005; Eccles, 1994; Lent, Brown, & Hackett, 1994; Schunk & Pajares, 2002).

The intervention did not directly influence STEM self-efficacy or STEM intentions. Results failed to show a significant effect of group condition on STEM self-efficacy or STEM intentions, indicating that the treatment was not effective at increasing participants' confidence in succeeding in STEM courses or careers upon immediate posttest. It is possible that the intervention had a delayed effect on STEM self-efficacy that was not detectable at immediate posttest, given that there were small but significant effects of group condition on IQ attitude and stereotype disbelief, and that these constructs were found to be related to STEM course and career self-efficacy via gender-specific pathways. As mentioned earlier, Yeager and Walton (2011) have argued that psychological education interventions like mine that target attitudes about intelligence and stereotype beliefs remove barriers to learning and create recursive effects that accumulate overtime. For example, in Blackwell, Trzesniewski, & Dweck's longitudinal study (2007), the effects of attitudes about intelligence started to set in only once students encountered setbacks to learning and/or negative stereotypes about women's math abilities. Those who believed that intelligence is malleable were less likely to give up in the face of challenge and ended up with the highest achievements. Perhaps a similar effect will occur over time such that STEM self-efficacy will be better protected for the treatment group participants compared to the comparison and control group participants when encountering academic challenges.

Gender is strongly related to STEM-related self-efficacy, interests and intentions. Gender was found to be a factor strongly related to STEM self-efficacy and

STEM intent, with gender predicting lower STEM course and self-efficacy and STEM intentions scores for females. Some researchers have suggested that the gender gap in science and math confidence may be closing (Britner & Pajares, 2006; Chen & Zimmerman, 2007). Around the same time that my participants were in middle school, these researchers had found middle school girls to be just as confident if not more confident in math and science as middle school boys. Unfortunately, my results are contradictory to this theory and suggest that the gender gap in STEM self-efficacy might still exist for college-age women.

Results of descriptive data on students' intentions to take different levels of math coursework in college suggest that the majority of participants are not planning to take the high-level math coursework needed to keep open the option of pursuing STEM disciplines. This was especially true for the women, as only 26% indicated intent to take Calculus 1 versus 48% of men; 15% intented to pursue Calculus 2 versus 37% of men; and 12% intended to pursue Calculus 3 versus 28% of men. This is consistent with prior research indicating strong gender gaps in self-reported interest in math coursework (e.g. Frenzel, Goetz, Pekrun, & Watt, 2010) and with Ma and Johnson's (2008) theory that women close doors to STEM disciplines in college by failing to take necessary mathematics coursework.

The treatment intervention helps improve academic achievement compared to no intervention. At the end of the semester, the students who had participated in the treatment intervention achieved the highest GPA (3.10), followed by those in the comparison group (3.03). The participants who were in the control group had the lowest GPA (2.86) by the end of their first academic semester. The pairwise difference between the treatment and control group GPAs was significant whereas the pairwise difference between the comparison group and control group GPAs were not significant. These results are consistent with the hypothesis that the treatment intervention helps improve academic achievement, and that the "growth mindset" training given to the treatment group was an important ingredient of success. However, the pairwise difference between the treatment and comparison group GPAs was also not statistically significant, indicating that the treatment group was only helpful compared to no intervention.

One explanation for these mixed results concerns the nature of the comparison intervention. The purpose of including it was to control for the possible effects of the experience of believing that one is called upon to serve as a mentor and the experience of writing an inspirational letter while reflecting on difficult achievements, as well to control for possible placebo effects of participating in an online training. Given that the comparison condition included these aspects, it is not surprising that the comparison group GPA was close to that of the treatment group's and higher than the control group's (though not significantly). Given that more than half of all participants indicated in the demographic questionnaire that they were enrolled in a writing course, it is also possible that the effect of the writing skill training received by the comparison group participants gave them a slight advantage in these courses and affected their GPAs. Without this advantage, perhaps the GPA of the comparison group would have been closer to that of the control group, which did not include an intervention. Unfortunately, I did not have access to students' grades in specific classes to test this theory and to see how students did in math and other STEM-related courses. Furthermore, not all participants granted permission for researcher access to their end of the semester GPA, so the power of the GPA analyses was lacking relative to the other analyses used for this study.

Although the effect of group condition on academic achievement as measured by GPA was statistically small ($\eta = .015$), that an hour-long educational intervention can result in an average GPA difference of a .24 compared to no intervention is quite remarkable. This could mean the difference between whether or not a student is able to obtain or maintain an academic scholarship, goes on academic probation, or meets the prerequisites to a major of his or her choosing.

Limitations of the study

There were several limitations to the design and instruments used in this study. One is the lack of baseline data on IQ attitude, stereotype disbelief, STEM self-efficacy, STEM intentions, and GPA needed to adequately assess for changes on these outcomes. In order to conceal the nature of the study to participants, pretests were not administered. However, students were randomly assigned to group conditions to help increase the likelihood that there were no preexisting differences between groups on these variables.

The validity of the STEM intention measure (Toker, 2010) is questionable and constitutes another limitation of the study. The results of scores on the STEM intentions items were not entirely consistent with the descriptive results of participants' open-ended responses to questions about their major and career intentions or to their indication of general ASU interest area. Whereas the results of the STEM intentions items indicated that students were generally uninterested in pursuing STEM, descriptive results suggested that one of the most popular interest areas for both men and women was "biological sciences, health and wellness," and a popular interest area for men was "engineering and technology." Results of coding the open-ended responses to questions about major and career interests also indicated that many students were interested in health-related fields. One possible explanation for these inconsistencies is that ASU groups categories of interest in an idiosyncratic manner in which STEM majors are grouped with non-STEM majors. For example, "health and wellness" includes social work as well as pre-med majors. Another possible reason is that students are not thinking of health-related fields such as nursing to be STEM-related. Furthermore, the individual items do not differentiate between different disciplines in STEM, making it impossible to assess how women's intentions may vary according to field.

Another limitation of the study was the lack of racial diversity in the participant sample. About 60% of participants identified as White. As Hill, Corbett, & Rose (2010) have acknowledged, "assumptions about the mismatch between women's interests and STEM are often based on the experiences of White women [but] gender and race do interact to create different cultural roles and expectations for women" (p. 23). This study cannot help address the need in the literature for more research on the interaction between gender and other aspects of identity, such as race and ethnicity, on women's persistence along STEM pathways.

Furthermore, the sample of male participants was relatively small compared to the sample of female participants. Therefore, the fit statistics of the final path model are biased towards the fit for the group of female students. Additional research is needed to assess the model with a larger sample of men before inferences can be made about a wellfitting path model for men describing relationships between IQ attitude, stereotype disbelief, STEM course and career self-efficacy, and STEM intentions.

My sample of participants may have also been biased toward students who were not well prepared for math, as they indicated being registered for college prep math courses. Many ASU colleges have specific prerequisites for declaring particular majors, but University College accepts any student who either wants to keep her or his mind open about a major or who was not accepted to the college of choice. Therefore, the results of the study may not be generalizable to the population of first-year undeclared undergraduates.

Perhaps the most crucial limitation of the study is the lack of longitudinal data. Without this data, no inferences of causality can be made about the results of path analysis, which identified relationships between IQ attitude, stereotype disbelief, STEM self-efficacy, and STEM intentions.

Conclusions and future directions

Overall, my results provide additional evidence that self-efficacy is an important predictor of academic and careers choices. That the women in my study reported generally low self-efficacy and tended to lack interest in pursuing STEM suggests the pipeline is still leaking for women early in their career trajectories, long before they might encounter the “chilly” work environments of STEM or the work life balance issues that are known to deter women at later career stages.

Results of path analysis indicate that, for these college-age women, gender stereotypes about math ability may play an important role in factors related to their intentions or lack thereof to engage in STEM-related pathways. The significant relationship found between "growth mindset" (IQ attitude) and math-gender stereotyping is consistent with Dweck's theory that growth mindset training might protect women from the negative effects of stereotyping. However, attitudes about the nature of intelligence did not significantly relate to confidence in STEM courses and careers when controlling for explicit beliefs about math-gender stereotypes among the women in my sample. One promising next direction for intervention research is the development of growth mindset training that more explicitly and persuasively discredits math-gender stereotypes in particular as well as teaches students to view intelligence as malleable in general.

While explicit gender-math stereotype beliefs were shown to significantly predict self-efficacy, they only accounted for a small variance. The women in my study also tended to already show strong stereotype disbelief overall. Including measures of implicit math-gender biases in models of STEM self-efficacy might help attain a more detailed picture of the impact of these stereotypes. Given that men and women reported similar math SAT and ACT scores, previous measures of math performance is not likely to be an important factor.

Results of open-ended questions about major and career intentions suggest that women may be planning to pursue health-related fields but do not consider themselves to be pursuing a STEM-related career. Therefore, another possible direction for future research is the development and assessment of instruments that better capture women's interest in pursuing different disciplines within STEM as well as different career levels within those disciplines. Fields including biology and chemistry have become much less male dominated than physics, engineering, and computer science fields (Hill, Corbett, & Rose, 2010). Better instruments are needed in order to tap into possible differences between factors related to occupational interest development in male-dominated STEM disciplines versus those that are more integrated.

In summary, this research project is possibly the first to employ a true experimental design to test the effect of growth mindset training on factors related to persistence in STEM and to assess a path model of how beliefs about the nature of intelligence relate to self-efficacy and career intentions. The results of this research suggest that a simple growth mindset tutorial and brief letter writing assignment, completed in under an hour, can help change attitudes about the nature of intelligence and bolster students' academic achievement across a semester of college. Furthermore, results indicate that attitudes about intelligence and beliefs about stereotypes are related constructs that predict STEM self-efficacy differently for women and men. Future research employing growth mindset training should employ a longitudinal design in order to help establish causality and to identify how the effects of such an intervention might change over time.

References

ACT, Inc. (2013). 2012 National and State Scores. *ACT Improve Yourself.* Retrieved from http://www.act.org/newsroom/data/2012/states.html

Ahn, J. (2002). Beyond single equation regression analysis: Path analysis and multi-stage regression analysis. *American Journal of Pharmaceutical Education, 66*, 37-42.

Ambady, N., Shih, M., Kim, A., & Pittinsky, L. T. (2001). Stereotype susceptibility in children: Effects of identity activation on quantitative performance. *Psychological Science, 12,* 385–389.

American Association of University Women. (1995). *How schools shortchange girls: The AAUW Report*. New York: Marlowe.

American Psychological Association Task Force on Women in Academe. (2000). *Women in academe: Two steps forward, one step back.* Washington, D.C.: American Psychological Association.

Arizona State University, Office of Institutional Analysis. (2010). *Enrollment Summary*. Retrieved from http://uoia.asu.edu/sites/default/files/ensmry/Enrollment_Summary_Fall_2010.pdf

Aronson, E. (1999). The power of self-persuasion. *American Psychologist*, *54,* 875–884.

Aronson, J., Fried, C.B., & Good, C. (2002). Reducing the effects of stereotype threat on African American college students by shaping theories of intelligence. *Journal of Experimental Social Psychology, 38,* 113–125.

Aronson, J., Lustina, M., Good, C., Keough, K., Brown, J. L., & Steele, C. M. (1999). When White men can't do math: Necessary and sufficient factors in stereotype threat. *Journal of Experimental Social Psychology, 35,* 11–23.

Astin, H.S. (1979). Patterns of women's occupations. In *J.A. Sherman & F.L. Denmark* (Eds.), *The Psychology of Women: Future Directions.* New York: Psychological Dimensions.

Atman, C.J., Sheppard, S. D., Turns, J. et al., (2010). *Enabling engineering student success: The final report for the Center for the Advancement of Engineering Education.* San Rafael, CA: Morgan & Claypool Publishers.

Bandura, A. (1977). Self-efficacy: Towards a unifying theory of behavior change. *Psychological Review, 84,* 191-214.

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

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: W. H. Freeman and Company.

Bandura, A., & Locke, E. A. (2003). *Negative self-efficacy and goal effects revisited.* Journal of Applied Psychology, 88, 87–99.

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

Beilock, S.L., Rydell, R.J., & McConnell, A.R. (2007). Stereotype threat and working memory: Mechanisms, alleviation, and spill-over. *Journal of Experimental Psychology: General*, *136,* 256–276.

Bekki, J. M., Smith, M. L., Bernstein, B. L., & Harrison, C. J. (2013). Effects of an Online Personal Resilience Training Program for Women in STEM Doctoral Programs. *Journal of Women and Minorities in Science and Engineering, 19 (*1*),* 17 – 35.

Bentler, P. M., & Chou, C. (1988). Practical issues in structural modeling. In J. S. Long (Ed.), *Common problems/proper solutions: Avoiding error in quantitative research* (pp. 161-192). Newbury Park, CA: Sage.

Bernstein, B. L. (2011). Managing barriers and building supports in science and engineering doctoral programs: Conceptual underpinnings for a new online training program for women. *Journal of Women and Minorities in Science and Engineering. 17(1),* 29-50.

Bernstein, B. L. & Russo, N. F. (2008). Explaining Too Few Women in Academic Science and Engineering Careers: A Psychosocial Perspective. In M. Paludi (Ed.), *The psychology of women at work: Challenges and solutions for our female workforce: Vol. 2. Obstacles and the identity juggle*. (pp. 1 – 33). Westport, CN: Praeger Press.

Berryman, S.E. (1983). *Who will do science? Minority and female attainment of science and mathematics degrees: Trends and causes.* New York: Rockefeller Foundation.

Betz, N. E. (2001). Career self-efficacy. In F. T. L. Leong & A. Barak (Eds.), *Contemporary models in vocational psychology: A volume in honor of Samuel H. Osipow* (pp. 55–78). Mahwah, NJ: Erlbaum. Betz, N. E. (2005).

Betz, N. E. (2005). Women's career development. In S. D. Brown & R. W. Lent (Eds.), *Career development and counseling: Putting theory and research to work* (pp. 253–277). New York: Wiley.

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.

Betz, N. E. & Hackett, G. (1987). The concept of agency in educational and career development. *Journal of Counseling Psychology, 34,* 299-308.

Betz, N. E., & Rottinghaus, P. J. (2006). Current research on parallel measures of interests and confidence for basic dimensions of vocational activity. *Journal of Career Assessment, 14,* 56–76.

Blackwell, L.S., Trzesniewski, K.H., & Dweck, C.S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: a longitudinal study and an intervention, *Child Development, 78*(1), 246-263.

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching, 43,* 485–499.

Brown, R.P., & Josephs, R.A. (1999). A burden of proof: Stereotype relevance and gender differences in math performance. *Journal of Personality and Social Psychology, 76,* 246–257.

Ceci, S.J., Williams, W.M., & Barntee, S.M. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin, 135,* 218-261.

Chen, P., & Zimmerman, B. J. (2007). A cross-national comparison study on the accuracy of self-efficacy beliefs of middle-school mathematics students. J*ournal of Experimental Education, 75,* 221–244.

Cohen, G. L. (2006). Reducing the racial achievement gap: A social-psychological intervention. *Science, 313,* 1307-1309.

Cohen, G. L., Garcia, J., Purdie-Vaughns, V., Apfel, N., & Brzustoski, P. (2009). Recursive Processes in Self-Affirmation: Intervening to Close the Minority Achievement Gap. *Science, 324,* 400-403.

Cole, S., & Fiorentine, R. (1991). Discrimination against women in science: The confusion of outcome with process. In H. Zuckerman & J. Bruer (Eds.), *The outer circle: Women in the scientific community,* New York: Norton Press.

Coley, R. J. (2001). *Differences in the gender gap: Comparisons across racial/ethnic groups in education and work.* Princeton, NJ: Educational Testing Service. Retrieved from https://www.ets.org/Media/Research/pdf/PICGENDER.pdf

Committee on Maximizing the Potential of Women in Academic Science and Engineering, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2006). *Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering.* Retrieved from http://www.ncbi.nlm.nih.gov/books/NBK9803/

Committee on Maximizing the Potential of Women in Academic Science and Engineering, & Committee on Science, Engineering, and Public Policy. (2007). *Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering*. Washington, D.C.: National Academies Press.

Crocker, J. & Major, B., (1989). Social stigma and self-esteem: The self-protective properties of stigma. *Psychological Review, 96,* 608-630.

Cutting, R. R. (2005). *Stereotype threat: An examination of domain identification and stereotype endorsement.* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 621052195)

Cvencek, D., Meltzoff, A.N., & Greenwald, A.G. (2011). Math–gender stereotypes in elementary-school children, *Child Development, 82,* 766–779.

Dawis, R. V. (1996). The theory of work adjustment and person-environment correspondence counseling. In D. Brown & L. Brooks (Eds.), *Career choice and development* (3rd ed., pp. 75-120). San Francisco, CA: Jossey-Bass.

Dawis, R. V. & Lofquist, L. H. (1976). *A psychological theory of work adjustment: An individual model and its application*. Minneapolis, MN: University of Minnesota Press.

Donnay, D. A. C., & Borgen, F. H. (1999). The incremental validity of vocational self efficacy: An examination of interest, self-efficacy, and occupation. *Journal of Counseling Psychology, 46,* 432–447.

Draganski, B., Gaser, C., Kempermann, G., Kuhn, H. G., Winkler, J., Büchel, C., & May, A. (2006). Temporal and spatial dynamics of brain structure changes during extensive learning. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 26*(23), 6314-6317.

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist, 41,* 1040–1048.

Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality, and development.* Philadelphia, PA: Taylor & Francis.

Dweck, C. S., & Leggett, E. L. (1988). A social cognitive approach to motivation and personality. *Psychological Review, 95,* 256–273.

Eccles, J. S., Jacobs, J. E., & Harold, R. E. (1990). Gender role stereotypes, expectancy effects, and parents' socialization of gender differences. *Journal of Social Issues, 46,* 183–201.

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.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy related beliefs. *Personality and Social Psychology Bulletin, 21*(3), 215–225.

Enders, C. K. (2010). *Applied Missing Data Analysis*. New York, NY: The Guliford Press.

Educational Testing Service. (2002). *Sex, race, ethnicity, and performance on the GRE General Test.* Retrieved from http://www.ssc.wisc.edu/~oliver/sociology/GREGroups99.pdf

Engle, R.W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11,* 19–23.

Erikson, E. H. (1968). *Identity: Youth and crisis.* New York, NY: Norton.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. Wittrock (Ed.), *Handbook of research on teaching* (pp. 119-161). New York, NY: Macmillan.

Etzkowitz, H., Kemelgor, C., & Uzzi, B. (2000). *Athena unbound: The advancement of women in science and technology.* Cambridge, England; Cambridge University Press.

Fassinger, R. E. (1985). A causal model of college women's career choice. *Journal of Vocational Behavior, 27,* 123-152.

Fassinger, R. E. (2002). Hitting the ceiling: Gendered barriers to occupational entry, advancement and achievement. In L. Diamant & J. Lee (Eds.), *The psychology of sex, gender, and jobs: Issues and solutions* (pp. 21–46). Westport, CT: Praeger.

Fassinger, R. E. (2005). Theoretical issues in the study of women's career development: Building bridges in a brave new world. In W. B. Walsh & M. L. Savickas (Eds.), *Handbook of vocational psychology* (3rd ed., pp. 85–124). Mahwah, NJ: Erlbaum.

Fassinger, R. E. (2008). Workplace diversity and public policy. Challenges and opportunities for psychology. *American Psychologist, 63*(4), 252-268.

Fassinger, R. E., & Gallor, S. M. (2006). Tools for remodeling the master's house: Advocacy and social justice in education and work. In R. L. Toporek, L. H. Gerstein, N. A. Fouad, G. Roysircar, & T. Israel (Eds.), *Handbook for social justice in counseling psychology: Leadership, vision, and action* (pp. 256–275). Thousand Oaks, CA: Sage.

Fitzgerald, L. F., & Harmon, L. W. (2001). Women's career development: A postmodern update. In F. T. L. Leong & A. Barak (Eds.), *Contemporary models in vocational psychology: A volume in honor of Samuel H. Osipow* (pp. 207–230). Mahwah, NJ: Erlbaum.

Flores, L. Y., Spanierman, L. S., Armstrong, P. I., & Velez, A. D. (2006). Validity of the strong interest inventory and skills confidence inventory with Mexican American high school students. *Journal of Career Assessment*, *14,* 183–202.

Forrest, L., & Mikolaitis, N. (1986). The relational component of identity: An expansion of career development theory. *The Career Development Quarterly, 35,* 76-88.

Frazier, P. A., Tix, A. P., & Barron, K. E. (2004). Testing moderator and mediator effects in counseling psychology research. *Journal of Counseling Psychology, 51*(1), 115-134.

Freeman, J. (1979). How to discriminate against women without really trying. In J. Freeman (Ed.), *Women: A feminist perspective* (2nd ed., pp 194-208). Palo Alto, CA.: Mayfield.

Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. G. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of Research on Adolescence, 20*(2), 507–537.

Frome. P., Corinne, A., Eccles, J, Bonnie, B. (2006). Why Don't They Want a Male-Dominated Job? An investigation of young women who changed their occupational aspirations. *Educational Research and Evaluation. 12*(4) 359-372.

Gelman, A., Hill, J., & Yajima, M. (2012). Why we (usually) don't have to worry about multiple comparisons. *Journal of Research on Educational Effectiveness, 5*, 189–211. doi:10.1080/19345747.2011.618213

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference.* 11.0 update (4th ed.). Boston, MA: Allyn & Bacon.

Gonzalez, P. M., Blanton, H., & Williams, K. J. (2002). The effects of stereotype threat and double-minority status on the test performance of Latino women. *Personality and Social Psychology Bulletin, 28,* 659–670.

Gonzalez, P., Guzman, J. C., Partelow, L., Pahlke, E., Jocelyn, L., Kastberg, D., et al. (2004). Highlights from the Trends in International Mathematics and Science Study (TIMSS) 2003 (NCES 2005–005). [U.S. Department of Education, National Center for Educational Statistics.] Washington, D.C.: U.S. Government Printing Office.

Good, C., Aronson, J., & Harder, J.A. (2000). *Stereotype threat and the kernel of truth.* (Unpublished manuscript). University of Texas.

Good, C., Aronson, J., & Inzlicht, M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *Applied Developmental Psychology, 24,* 645–62.

Good, C., Rattan, A., Dweck, C.S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology, 102,* 100-717.

Gottfredson, L. S. (1981). Circumscription and compromise: A developmental theory of occupational aspirations. *Journal of Counseling Psychology, 28,* 545-579.

Gottfredson, L. S. (1996). Gottfredson's theory of circumscription and compromise. In D. Brown & L. Brooks (Eds.), *Career choice and development (3rd ed., pp. 179-232).* San Francisco: Jossey-Bass.

Gottfredson, L. S., & Lapan, R. T. (1997). Assessing gender-based circumscription of occupational aspirations. *Journal of Career Assessment, 5*(4), 419-441.

Graham, S., & Perin, D. (2007). *Writing next: Effective strategies to improve writing of adolescents in middle and high schools –A report to Carnegie Corporation of New York. Washington, D.C.: Alliance* for Excellent Education.

Greenough, W.T., & Chang, F.F. (1989). Plasticity of synapse structure and pattern in the cerebral cortex. In A. Peters & E.G. Jones (Eds.), Cerebral Cortex: Vol. 7 (pp. 391-440). New York, NY: Plenum Press.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. K. L. (1998). Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology, 74,* 1464– 1480.

Gwilliam, L. R., & Betz, N. E. (2001). Validity of measures of math- and science-related self-efficacy for African Americans and European Americans. *Journal of Career Assessment, 9,* 261-281.

Hackett, G. (1985). Role of mathematics self-efficacy in the choice of mathematics-related majors of college women and men: A path analysis. *Journal of Counseling Psychology, 32*, 47-56.

Hackett, G. (1995). Self-efficacy in choice and development. In A. Bandura (Ed.), *Self-efficacy in Changing Societies*. (pp. 232- 258). Cambridge, England: Cambridge University Press.

Hackett, G., & Betz, N. E. (1981). A self-efficacy approach to the career development of women. *Journal of Vocational Behavior, 18,* 326-336.

Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education, 20,* 261-273.

Hackett, G., Betz, N. E., Casas, J. M., & Rocha-Singh, I. A. (1992). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. *Journal of Counseling Psychology, 39,* 527-538.

Hackett, G., & Lent, R. W. (1992). Theoretical advances and current inquiry in career psychology. In S. D. Brown & R. W. Lent (Eds.), *Handbook of Counseling Psychology*. (2nd Ed., pp. 419-452). New York, NY: Wiley.

Hair, J.F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). Multivariate data analysis (5th ed.). Englewood Cliffs, NJ: Prentice Hall, Inc.

Hall, R. & Sandler, B. (1982). The classroom climate: a chilly one for women? *Project on the Status of Education of Women.* Washington, D.C.: Association of American Colleges.

Halpern, D. F, Benbow, C. P., Geary, D. C., Gur, R. C., Hyde J. S., & Gernbacher, M. A., (2007). The science of sex differences in science and mathematics. *Psychological Science in the Public Interest, 8,* 1–51.

Harding, S. G. (1991). *Whose science? Whose knowledge? Thinking from women's lives.* Ithaca, N.Y.: Cornell University Press.

Harter, S. (1990). Processes underlying adolescent self-concept formation. In R. Montmayor, G. R. Adams, & T. P. Gullotta (Eds.), *From childhood to adolescence: A transitional period?* (pp. 205–239). Newbury Park, CA: Sage.

Henderson, V. & Dweck, Carol S. (1990). Adolescence and Achievement. In S. Feldman and G. R. Elliott (Eds.), *At the Threshold: The Developing Adolescent.* Cambridge, MA: Harvard University Press.

Herzig, A. H. (2004). Becoming mathematicians: Women and students of color choosing and leaving doctoral mathematics. *Review of Educational Research, 74*(2), 171-214.

Hewlett, Sylvia. (2007). *Off-ramps and on-ramps: Keeping talented women on the road to success.* Boston, MA: Harvard Business School Press.

Hill, C. Corbett, C. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics.* Washington, D.C.: AAUW.

Hirsh, L.S., Gibbons, S.J., Kimmel, H., Rockland, R., & Bloom, J. (2003). *High School Attitudes to and Knowledge About Engineering Survey.* Paper presented at the Frontiers in Education Conference co-sponsored by American Society for Engineering Education (ASEE) and Education Society of Institute of Electrical and Electronics Engineers (IEEE).

Holland, J. L. (1973). *Making vocational choices: A theory of careers.* Englewood Cliffs, NJ: Prentice Hall.

Hollenshead, C., Wenzel, S., Lazarus, B., & Nair, I. (1996). The graduate experience in the sciences and engineering: Rethinking gendered institutions. In C. Davis, A. Ginorio, C. Hollenshead, B. Lazarus, & P. Raymon (Eds.), *The equity equation* (pp. 122-162). San Francisco, CA: Jossey-Bass.

Hong, Y., Chiu, C., & Dweck, C. S. (1995). Implicit theories of intelligence: Reconsidering the role of confidence in achievement motivation. In M. H. Kernis (Ed.), *Efficacy, agency, and self-esteem* (pp. 197–216). New York, NY: Plenum.

Hoyle, R. H., & Robinson, J. I. (2003). Mediated and moderated effects in social psychological research: Measurement, design, and analysis issues. In C. Sansone, C. Morf, & A. T. Panter (Eds.), *Handbook of methods in social psychology.* Thousand Oaks, CA: Sage.

Hoyle, R. H., & Smith, G. T. (1994). Formulating clinical research hypotheses as structural models: A conceptual overview. *Journal of Consulting and Clinical Psychology, 62*, 429–440.

Hu, L., & Bentler, P. M. (1995). Evaluating model fit. In R. H. Hoyle (Ed.), *Structural equation modeling: Concepts, issues, and applications* (pp. 76-99). Thousand Oaks, CA: Sage.

Hyde, J. S. & Durik, A. M. (2005). Gender, competence, and motivation. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 375-391). New York, NY: Guilford Press.

Hyde, J.S., Fennema, E., Ryan, M., Frost, L.A., & Hopp, C. (1990). Gender comparisons of mathematics attitudes and affect: A meta-analysis. *Psychology of Women Quarterly, 25,* 364-378.

Johns, M., Schmader, T., & Martens, A. (2005). Knowing is half the battle: Teaching stereotype threat as a means of improving women's math performance. *Psychological Science, 16*(3), 175-179.

Judd, C. M., & Kenny, D. A. (1981). Process analysis: Estimating mediation in treatment evaluations. *Evaluation Review, 5*, 602–619.

Kenny, D. A., Kashy, D. A., & Bolger, N. (1998). Data analysis in social psychology. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The Handbook of Social Psychology* (4th ed., pp. 233–265). New York, NY: Oxford University Press.

Kite, M. E., Deaux, K., Haines, E. L. (2008). Gender stereotypes. In F. L. Denmark, M. A. Paludi (Eds.), *Psychology of women: A handbook of issues and theories* (2nd ed. pp. 205-236). Westport, CT: Praeger Publishers/Greenwood Publishing.

Lapan, R. T., Boggs, K. R., & Morrill, W. H. (1989). Self-efficacy as a mediator of investigative and realistic general occupational themes on the Strong-Campbell Interest Inventory. *Journal of Counseling Psychology, 36,* 176-182.

Lapan, R. T., Shaughnessy, P., & Boggs, K. (1996). Efficacy expectations and vocational interests as mediators between sex and choice of math/ science college majors: A longitudinal study. *Journal of Vocational Behavior, 49,* 277-291.

Leggett, E.L. (1985, April). *Children's entity and incremental theories of intelligence: Relationships to achievement behavior.* Paper presented at the annual meeting of the Eastern Psychological Association, Boston, MA.

Lent, R. W., Brown, S. D., Brenner, B., Chopra, S. B., Davis, T., Talleyrand, R., Suthakaran, V. (2001). The role of contextual supports and barriers in the choice of math/ science educational options: A test of social cognitive hypotheses. *Journal of Counseling Psychology, 48,* 474–483.

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

Lent, R. W., Brown, S. D., & Hackett, G. (2000). Contextual supports and barriers to career choice: A social cognitive analysis. *Journal of Counseling Psychology, 31,* 356-362.

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,* 165-169.

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,* 293-298.

Lent, R. W., Brown, S. D., Schmidt, J., Brenner, B., Lyons, H., & Treistman, D. (2003). Relation of contextual supports and barriers to choice behavior in engineering majors: Test of alternative social cognitive models. *Journal of Counseling Psychology, 50,* 458–465.

Lent, R. W., Brown, S. D., Sheu, H., Schmidt, J., Brenner, B. R., Gloster, C. S., Wilkins, G., Schmidt, L.C., & Lyons, H. (2005). Social cognitive predictors of academic interests and goals in engineering: Utility for women and students at historically black universities. *Journal of Counseling Psychology, 52*(1), 84-92.

Lent, R. W., Hung-Bin, S., Gloster, C.S., & Wilkins, G. (2010). Longitudinal test of the social cognitive model of choice in engineering students at historically Black universities. *Journal of Vocational Behavior*, *76*, 387-394.

Lent, R. W., Larkin, K. D., & Brown, S. D. (1989). Relation of self-efficacy to inventoried vocational interests. *Journal of Vocational Behavior, 34,* 279-288.

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

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,* 424-430.

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,* 223-236.

Lesko, A. C., & Corpus, J. H. (2006). Discounting the difficult: How high-identified women respond to stereotype threat. *Sex Roles*, *54*(1/2), 113-125.

Luzzo, D.A. (1999). Identifying the career decision-making needs of nontraditional college students. *Journal of Counseling & Development*, *77*(2), 135-140.

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

Ma, X., & Johnson, W. (2008). Mathematics as the critical filter: Curricular effects on gendered career choices. In H. M. G. Watt & J. S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessment of individual, social, and cultural influences* (pp. 55 – 83). Washington, D.C.: American Psychological Association.

MacKinnon, D. P., Lockwood, C. M., &Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*, *39*, 99–128.

MCESA (2012). Maricopa County Education Service Agency. Retrieved from http://www.maricopa.gov/schools/

Major, B., & Crocker, J. (1993). Social stigma: The consequences of attributional ambiguity. In D. M. Mackie & D.L. Hamilton (Eds.) *Affect, cognition, and stereotyping: Interactive process in group perception.* (pp. 345-370). San Diego, CA: Academic Press.

Major, B., Spencer, S., Schmader, T., Wolfe, C., & Crocker, J. (1998). Coping with negative stereotypes about intellectual performance: The role of psychological disengagement. *Personality and Social Psychology Bulletin, 24*, 34–50.

Markus, H., & Kunda, S. (1986). Stability and malleability of the self-concept. *Journal of Personality and Social Psychology, 51*(4), 858-866.

Markus, H., & Nurius, P. (1986). Possible selves. *American Psychologist, 41*(9), 954-969.

Markus, H., & Wurf, E. (1987). The dynamic self-concept: A social psychological perspective. In M. R. Rosenszweig & L. W. Porter (Eds.), *Annual Review of Psychology* (Vol. 38).

Malle, B.F. (2006). The actor-observer asymmetry in attribution: A (surprising) meta-analysis. *Psychological Bulletin*, *132*(6), 895-919.

Martens, A., Johns, M., Green, J., & Schimel, J. (2006). Combating stereotype threat: The effect of self-affirmation on women's intellectual performance. *Journal of Experimental Social Psychology, 42,* 236–243.

Marx, D.M., & Roman, J.S. (2002). Female role models: Protecting women's math test performance. *Personality and Social Psychology Bulletin, 28,* 1183–1193.

Mason, M.A., Stacy, A. & Goulden, M. (2003). The UC faculty work and family survey. Retrieved from http://ucfamilyedge.berkeley.edu/workfamily/htm

Matsui, T., Ikeda, H., & Ohnishi, R. (1989). Relations of sex-typed socializations to career self-efficacy expectations of college students. *Journal of Vocational Behavior, 35,* 1-16.

McIntyre, R. B., Paulson, R. M., & Lord, C. G. (2003). Alleviating women's mathematics stereotype threat through salience of group achievements. *Journal of Experimental Social Psychology, 39,* 83–90.

McKown, C., & Weinstein, R. S. (2003). The development and consequences of stereotype consciousness in middle childhood. *Child Development, 74,* 498–515.

Miyake, A. Kost-Smith, L.E., Finkelstein, N.D., Pollock, S.J., Cohen, G.L. & Ito, T.A. (2010). Reducing the gender achievement gap in college science: A classroom study of values affirmation. *Science, 330,* 1234-1237.

Mulhern, F. & Rae, G. (1998). Development of a shortened form of the Fennema–Sherman mathematics attitudes scales. *Educational and Psychological Measurement, 58,* 295–306

Muthén, L.K. and Muthén, B.O. (2012). *Mplus User's Guide.* (7th ed.) Los Angeles, CA: Muthén & Muthén

NAS/NAE/IOM (2007). *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* Washington, DC: The National Academies Press.

National Center for Educational Statistics. (2001). *Competing choices: Men and women's paths after earning a Bachelor's degree. Statistical analysis report.* Retrieved from http://nces.ed.gov/pubs2001/2001154.pdf

National Science Foundation. (2008). *Science and engineering indicators 2008.* Retrieved from http://www.nsf.gov/statistics/seind08/

National Science Foundation. (2004). *Women, minorities and persons with disabilities in science and engineering: 2004.* Arlington, VA: National Science Foundation.

Nauta, M. N., Kahn, J. H., Angell, J. W., & Cantareilli, 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.

Norris, A. (2001). Path Analysis. In B. Hazard Munro (Ed.), *Statistical methods or health care research* (pp. 355-378). Philadelphia, PA: Lippincott.

Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Math = male, me = female, therefore math ≠ me. *Journal of Personality and Social Psychology, 83*(1), 44-59.

Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Harvesting implicit group attitudes and beliefs from a demonstration website. *Group Dynamics, 6*(1), 101-115.

Nguyen, H.D. & Ryan, A.M. (2008). Does stereotype threat affect test performance of minorities and women? A meta-analysis of experimental evidence. *Journal of Applied Psychology, 93,* 1314-1334.

O'Brien, K. M., Fassinger, R. E. (1993). A causal model of the career orientation and career choice of adolescent women. *Journal of Counseling Psychology, 40*(4), 456-469.

Pajares, F., & Miller, M. D. (1995). Mathematics self-efficacy and mathematics performances: The need for specificity of assessment. *Journal of Counseling Psychology, 42,* 190-198.

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

Paulhus, D. L. (1984). Two-component models of socially desirable responding. *Journal of Personality and Social Psychology, 46,* 598–609.

Paulhus, D. L. (1994). *Reference manual for BIDR Version 6.* Vancouver, Canada: University of British Columbia.

Pedhazur, E. (1982*). Multiple regression in behavioral research explanation and prediction*. New York, NY: Holt, Rinehart and Winston.

Petty, R. E., & Wegener, D. T (1998). Attitude change: Multiple roles for persuasion variables. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *Handbook of social psychology* (3rd ed., Vol. 1, pp. 323–329). Boston, MA: McGraw–Hill.

Pinel, E.C. (1999). Stigma consciousness: The psychological legacy of social stereotypes. *Journal of Personality and Social Psychology, 76*, 114-128.

Post, P., Stewart, M. A., & Smith, P. L. (1991). Self-efficacy, interest, and consideration of math/science and non-math/ science occupations among Black freshmen. *Journal of Vocational Behavior, 38,* 179-186.

Preston, A. E. (2004). *Leaving science: Occupational exit from scientific careers.* New York, NY: Russell Sage Foundation.

QuestionPro Survey Software (2012) [Online software]. Seattle: Question Pro, Inc. Retrieved from http://www.questionpro.com

Quinn, D. M., & Spencer, S. J. (2001). The interference of stereotype threat with women's generation of mathematical problem-solving strategies. *Journal of Social Issues, 57,* 55– 71.

Quintana, S. M., & Maxwell, S. E. (1999). Implications of recent developments in structural equation modeling for counseling psychology. *The Counseling Psychologist, 27*(4), 485-527.

Ramsden, S., Richardson, F.M., Josse, G., Thomas, M., Ellis, C., Shakeshart, C., Seguier, M., & Price, C. (2011). Verbal and non-verbal intelligence changes in the teenage brain. *Nature, 479,* 113–116.

Rudman, L. A., & Glick, P. Prescriptive gender stereotypes and backlash toward agentic women. *Journal of Social Issues, 57* (4), 743-762.

Russell, D. W., Kahn, J. H., Spoth, R., & Altmaier, E. M. (1998). Analyzing data from experimental studies: A latent variable structural equation modeling approach. *Journal of Counseling Psychology, 45*(1), 18-29.

Sadker, M., & Sadker, D. (1994). *Failing at fairness: How our schools cheat girls.* New York, NY: Simon & Schuster.

Sandler, B., & Hall, R. (1986). *The campus climate revisited: Chilly for women faculty, administrators, and graduate students.* Project on the Status and Education of Women Washington, D.C.: Association of American Colleges. Retrieved from http://files.eric.ed.gov/fulltext/ED282462.pdf

Satorra, A. (2000). Scaled and adjusted restricted tests in multi-sample analysis of moment structures. In R.D.H. Heijmans, D.S.G. Pollock, & A. Satorra (Eds.), *Innovations in multivariate statistical analysis. A Festschrift for Heinz Neudecker* (pp.233-247). London, England: Kluwer Academic Publishers.

Schmader, T. (2010). Stereotype threat deconstructed. *Current Directions in Psychological Science, 19(1)*, 14-18.

Schmader, T., & Johns, M. (2003). Convergent evidence that stereotype threat reduces working memory capacity. *Journal of Personality and Social Psychology, 85,* 440–452.

Schreiber, J. B, A. Nora, F. K Stage, E. A. Barlow, and J. King. 2006. "Reporting Structural Equation Modeling and Confirmatory Factor Analysis: A Review." *Journal of Educational Research* 99 (6): 323–37.

Sekaquaptewa, D., & Thompson, M. (2003). Solo status, stereotype threat, and performance expectancies: Their effects on women's performance. *Journal of Experimental Social Psychology, 39*(1), 68-74.

Shih, M. J.; Pittinsky, T.L.; Ho, G. C. (2012). Stereotype boost: Positive outcomes from the activation of positive stereotypes. In Inzlicht, M.; Schmader, T. *Stereotype Threat: Theory, Process, and Application* (pp. 141–156). New York, NY: Oxford University Press.

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 the educational psychology series* (pp. 15–31). San Diego, CA: Academic Press.

Sinatra, G. M. (2005). The "warming trend" in conceptual change research: The legacy of Paul R. Pintrich. *Educational Psychologist, 40*(2), 107-115.

Smith, T. W. (1990). *Ethnic images.* GSS Topical Report No 19. National Opinion Center.

Spelke, E.S. (2005). Sex differences in intrinsic aptitude for mathematics and science? A critical review. *American Psychologist, 60*(9), 950-958.

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. *Journal of Experimental Social Psychology, 35,* 4–28.

StatTrek.com (2012). Random Data Generator [Online software]. Retrieved from http://stattrek.com/statistics/random-number-generator.aspx

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52,* 613-629.

Steele, C. (1992). Race and the schooling of black Americans. *The Atlantic (Boston, Mass.: 1981), 269*(4), 68.

Steele, C., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69,* 797-811.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69,* 797–811.

Steele, C.M., Spencer, S. J., Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. *Advances in Experimental Social Psychology, 34*, 379- 439.

Stone, J., Lynch, C. I., Sjomeling, M., & Darley, J. M. (1999). Stereotype threat effects on Black and White athletic performance. *Journal of Personality and Social Psychology, 77,* 1213–1227.

Super, D. E. (1990). A life-span, life-space approach to career development. In D. Brown & L. Brooks (Eds.), *Career choice and development: Applying contemporary theories to practice.* (2nd ed., pp. 197-261). San Francisco, CA: Jossey-Bass.

Super, D.E., Savickas, M.L., & Super, C.M. (1996). The life-span, life-space approach to careers. In D. Brown & L. Brooks, (Eds.), *Career choice and development* (3rd ed., pp. 121-178). San Francisco, CA: Jossey-Bass.

Swim, J. K. (1994). Perceived versus meta-analytic effect sizes: An assessment of the accuracy of gender stereotypes. *Journal of Personality and Social Psychology, 66*, 21–36.

Toker, Y. & Ackerman, P. L. (2011). Utilizing occupational complexity levels in vocational interest assessments: Assessing interests for STEM areas. *Journal of Vocational Behavior, 80*(2), 524-544.

Tracey, T. J. G. (2002a). Development of interests and competency beliefs: A 1-year longitudinal study of fifth- to eighth-grade students using the ICA-R and structural equation modeling. *Journal of Counseling Psychology, 49*, 148–163.

Tracey, T. J. G., & Hopkins, N. (2001). Correspondence of interests and abilities with occupational choice. *Journal of Counseling Psychology, 48*, 178–189.

Tracey, T, J, G, & Robbins, S, B, (2005), Stability of interests across ethnicity and gender: A longitudinal examination of Grades 8 through 12, *Journal of Vocational Behavior, 67,* 335-364.

Tracey, T, J, G, Robbins, S, B,, & Hofsess, C, D, (2005), Stability and change in adolescence: A longitudinal analysis of interests from Grades 8 through 12, *Journal of Vocational Behavior, 66,* 1-25.

Tracey, T. J. G., & Sodano, S. M., (2008). Issues of stability and change in interest development, *The Career Development Quarterly, 57*(1), 51-62.

Walton, G. M. & Cohen, G. L. (2003). Stereotype lift. *Journal of Experimental Social Psychology 39*(5), 456–467.

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. *Journal and Personality and Social Psychology, 92*(1), 82-96.

Wheeler, K. G. (1983). Comparisons of self-efficacy and expectancy models of occupational preferences for college males and females. *Journal of Occupational Psychology, 56,* 73-78.

Wilson, T.B. (2006). The power of social psychological interventions. *Science, 313,* 1251.

Woolf, K., McManus, I.C., Gill, D. and Dacre, J.E. (2009). The effect of a brief social intervention on the examination results of UK medical students: a cluster randomized controlled trial, *BMC Medical Education,* 9:35

Wu, A. D. & Zumbo, B.D. (2008). Understanding and using mediators and moderators. *Social Indicators Research, 87,* 367–392 doi:10.1007/s11205-007-9143-1

Wyer, M. (2003). Intending to stay: Images of scientists, attitudes toward women, and gender as influences on persistence among science and engineering majors. Journal *of Women and Minorities in Science and Engineering, 9,* 1-16.

Yeager, D.S. & Walton, G.M. (2011). Social-psychological interventions in education: They're not magic. *Review of Educational Research*, *81*(2), 267-301.

Xie, Y., & Shauman, K. A. (2003). *Women in science: Career processes and outcomes.* Cambridge, MA: Harvard University Press.

Xin, M., & Willis, J. (2008) Mathematics as the critical filter: Curricular effects on gendered career choices. In H. M. G. Watt & J. S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences,* (pp. 55-83). Washington, D.C.: American Psychological Association.

Zimmerman, B. (1995). Self-efficacy and educational development. In A. Bandura (Ed.), *Self-efficacy in Changing Societies*. New York, NY: Cambridge University Press.

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

To: Bianca Bernstein EDB
From: Mark Roosa, Chair Soc Beh IRB
Date:07/20/2012
Committee Action: Expedited Approval

Approval Date: 07/20/2012

Review Type: Expedited F7

IRB Protocol #:1207008018
Study Title:

Effects of brain plasticity education on STEM career intentions of undergraduate women

Expiration Date: 07/19/2013
The above-referenced protocol was approved following expedited review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date. You may not continue any research activity beyond the expiration date without approval by the Institutional Review Board.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX B

DEMOGRAPHIC QUESTIONNAIRE

1. Please indicate below whether or not you would like to grant your permission for the researcher of the study to access your end-of-the-semester grade point average.

   Yes, I give permission for the researcher to access my end-of-the-semester GPA.

   No, I do not give permission for the researcher to access my end-of-the-semester GPA.

2. Please generate a code based on the month of your birthday, the first letter of your middle name (use your first name if you don't have a middle name), and the last 2 digits of your student ID.

   Please go through the following two examples, and then provide your code.
   Example 1: Born in August, middle name is Brian, student ID is XXXX--XX--XX06. The code is 08B06.
   Example 2: Born in November, middle name is Ann, student ID is XXXX--XX--XX14. The code is 11A14.

BEFORE MOVING FORWARD, MAKE SURE YOUR CODE IS IN THE SPECIFIED FORMAT AND CHECK FOR TYPOS. Also, MAKE SURE TO SAVE YOUR CODE IN A SAFE PLACE. You will need to use this code to access the second part of this study/assignment: "Pen Pal Letter- Part 2."

Your code is:

3. Please type in your email address below. *A link to Pen Pal Letter- Part 2 will be sent to this email address.* Double check that you entered the correct email address before moving forward.

4. What is your age?

5. What is your gender? (Female/Male)

6. Please select your racial/ethnic background
   African American/Black
   Asian American/Pacific Islander
   European American/Caucasian/White
   Hispanic American/Latino
   Native American/Alaskan Native/Native Hawaiian
   Multiethnic/Multiracial (please specify)
   I decline to answer
   Other (please specify)
7. Please select your current exploratory track status.
   Exploratory- Engineering, Math, Technology, & Physical Sciences
   Exploratory- Fine Arts/Humanities/Design
   Exploratory- Health and Life Sciences
   Exploratory- Social/Behavioral Sciences

I do not know my exploratory track status

8. What is your country of origin?
   US
   Other (please specify)

9. Are you a full time ASU student? (Yes/No)

10. Is this your first semester as an ASU student? (Yes/No)

11. Are you a transfer student? (Yes/No)

12. Please select your current class standing.
    Freshman (a student who has earned 24 or fewer credits)
    Sophomore (a student who has earned 25–55 credits)
    Junior (a student who has earned 56–86 credits)
    Senior (a student who has earned 87 or more credits)

13. Did you take the SAT?
    Yes
    No (survey skips to # 16)

14. What was your mathematics SAT score?
    200-290
    300-390
    400-490
    500-590
    600-690
    700-800

15. What was your writing SAT score?
    200-290
    300-390
    400-490
    500-590
    600-690
    700-800

16. Did you take the ACT?
    Yes
    No

17. What was your English score on the ACT?

18. What was your mathematics score on the ACT?

19. What was your reading score on the ACT?

20. What was your science reasoning score on the ACT?

21. Of the courses listed below, please select the courses you are currently registered for this semester. Select all that apply.
    - Intro to Academic Writing
    - Intro to Academic Writing for International Students
    - First-Year Composition
    - Advanced First-Year Composition
    - English for Foreign Students
    - Enhanced Freshman Mathematics
    - College Mathematics
    - College Algebra (MA)
    - Pre-calculus
    - Brief Calculus
    - Math for Business Analysis
    - Calculus for Life Science
    - Calculus for Engineers
    - Calculus w/ Analytic Geometry
    - Modern Differential Equations
    - Lineal Algebra
    - Applied Linear Algebra
    - Intermediate Calculus
    - Advanced Calculus I
    - Geometry I
    - A Natural Science- Quantitative course (SQ)
    - A Natural Science- General course (SG)
    - A Social/Behavioral Science (SB) course
    - A Humanities/Fine Arts/Design (HU) course
    - I do not know
    - Other (please specify)

22. Please indicate the degree to which you are undecided about the major you would like to pursue on the following scale.

23. Please indicate the degree to which you are undecided about the career you would like to pursue on the following scale.

APPENDIX C

INDEX OF MALLEABILITY SCALE (ITEMS # 1, 5, & 8) AND "FILLER" ITEMS

Please rate how much you agree with each of the following statements, on the following scale:

	Strongly agree	Agree	Somewhat agree	Somewhat disagree	Disagree	Strongly disagree
You have a certain amount of intelligence and you really can't do much to change it. *						
You have a certain type of personality, and you really can't do much to change it. *						
Even with a bad childhood, you still have an equal opportunity of success later in life. *						
People are inherently good. *						
You can learn new things but you really can't change your basic intelligence. *						
People are inherently selfish. *						
Every child should have equal access to quality education. *						
Your intelligence is something about you that you can't really change that much. *						

APPENDIX D

"BELIEF" SCALE (ITEMS # 2, 3, 5, 6, 7, 10) AND "FILLER" ITEMS

Please rate how much you agree with each of the following statements, on the following scale:

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
I believe to be true the stereotype regarding males as more aggressive compared to females. *	○	○	○	○	○	○	○
I believe to be true the stereotype regarding females as poorer in math than males. *	○	○	○	○	○	○	○
Males are better at math than females. *	○	○	○	○	○	○	○
Females are more nurturing compared to males. *	○	○	○	○	○	○	○
The stereotype about females being poorer at math than males is not true. *	○	○	○	○	○	○	○
I believe in the stereotype that females are not as capable as males in the math arena. *	○	○	○	○	○	○	○
I do not believe the stereotype that females are not as capable as males in the math arena. *	○	○	○	○	○	○	○
The differences between males and females are mostly biological. *	○	○	○	○	○	○	○
The differences between males and females are mostly environmental. *	○	○	○	○	○	○	○
I endorse the stereotype that females are not as capable as males in the math arena. *	○	○	○	○	○	○	○

APPENDIX E

STEM COURSE SELF-EFFICACY INCLUDING “FILLER” ITEMS

Please indicate your confidence in your ability to complete each of the following courses (or an equivalent course) offered at Arizona State University with a B or better:

	no confidence at all									complete confidence
Chemistry *	○	○	○	○	○	○	○	○	○	○
Philosophy *	○	○	○	○	○	○	○	○	○	○
Pre-calculus *	○	○	○	○	○	○	○	○	○	○
Calculus *	○	○	○	○	○	○	○	○	○	○
Psychology *	○	○	○	○	○	○	○	○	○	○
Sociology *	○	○	○	○	○	○	○	○	○	○
Engineering *	○	○	○	○	○	○	○	○	○	○
Physics *	○	○	○	○	○	○	○	○	○	○
Biology *	○	○	○	○	○	○	○	○	○	○
Geometry *	○	○	○	○	○	○	○	○	○	○
Statistics *	○	○	○	○	○	○	○	○	○	○
Organic Chemistry *	○	○	○	○	○	○	○	○	○	○
Computer programming *	○	○	○	○	○	○	○	○	○	○
Sustainability *	○	○	○	○	○	○	○	○	○	○

APPENDIX F

STEM CAREER SELF-EFFICACY SCALE WITH “FILLER” ITEMS

Please indicate your degree of confidence in your ability to complete the job duties associated with the following different fields:

	completely unsure									completely sure
engineering *										
journalism *										
computer science *										
geology *										
mathematics *										
physics *										
environmental science *										
technology *										
architecture *										
chemistry *										
astronomy *										
advertising *										
teaching *										
life sciences *										
accounting *										
counseling *										
biology *										

APPENDIX G

INTENT TO PERSIST IN STEM SCALE INCLUDING “FILLER” ITEMS

Please rate how much you agree with each of the following statements on the following scale:

	Very untrue of me	Untrue of me	Somewhat untrue of me	Somewhat true of me	True of me	Very true of me
Next semester I intend to take courses related to engineering, technology, sciences, or mathematics. *	○	○	○	○	○	○
Next semester I intend to take courses related to the social sciences, humanities, or arts. *	○	○	○	○	○	○
Next year I intend to take courses related to engineering, technology, sciences, or mathematics. *	○	○	○	○	○	○
Next year I intend to take courses related to the humanities, social sciences, or arts. *	○	○	○	○	○	○
I intend to pursue a major related to engineering, technology, sciences, or mathematics. *	○	○	○	○	○	○
I intend to pursue a major related to the humanities, social sciences, or arts. *	○	○	○	○	○	○
I intend to get a Bachelors degree in a major related to engineering, technology, sciences, or mathematics. *	○	○	○	○	○	○
I intend to get a Bachelors degree in a major related to the humanities, social sciences, or arts. *	○	○	○	○	○	○
I am planning to apply to a master's degree program in a field related to engineering, technology, sciences, or mathematics. *	○	○	○	○	○	○

I am planning to apply to a master's degree program in a field related to the humanities, social sciences, or arts. *	○	○	○	○	○	○
I intend to get a masters degree in a field related to engineering, technology, sciences, or mathematics. *	○	○	○	○	○	○
I intend to get a masters degree in a field related to the humanities, social sciences, or arts. *	○	○	○	○	○	○
I would like to pursue a doctoral degree in an engineering, technology, science, or mathematics related area. *	○	○	○	○	○	○
I would like to pursue a doctoral degree in a humanities, social science, or art related area. *	○	○	○	○	○	○
I am sure that I would like to continue with my education in engineering, technology, sciences, or mathematics. *	○	○	○	○	○	○
I am sure that I would like to continue with my education in the humanities, social sciences, or arts. *	○	○	○	○	○	○
I intend to find a job in engineering, science, technology, or mathematics. *	○	○	○	○	○	○
I intend to find a job in the humanities, social sciences, or arts. *	○	○	○	○	○	○
I can see myself working in engineering, science, technology, or mathematics. *	○	○	○	○	○	○

I can see myself working in the humanities, social sciences, or arts. *	○	○	○	○	○	○
I am planning on earning a living working in engineering, science, mathematics, or technology. *	○	○	○	○	○	○
I am planning on earning a living working in the humanities, social sciences, or arts. *	○	○	○	○	○	○
I intend to devote my career to an area related to engineering, sciences, or mathematics. *	○	○	○	○	○	○
I intend to devote my career to an area related to the humanities, social sciences, or arts. *	○	○	○	○	○	○

APPENDIX H

PSYCHOMETRIC PROPERTIES OF STEM INTENTIONS MEASURE

Table H1

*Factor Loadings from Principle Axis Factoring: Communalities, Eigenvalues, and Percentages of Variance for Intent to Persist in STEM ("STEM Intentions") **

Item		Factor Loading	Communality
1.	Next semester I intend to take courses related to STEM.*	.85	.73
2.	Next year I intend to take courses related to STEM.	.86	.74
3.	I intend to pursue a major related to STEM.	.93	.87
4.	I intend to get a Bachelors degree in a major related to STEM.	.94	.88
5.	I am planning to apply to a master's degree program in a field related to STEM.	.87	.76
6.	I intend to get a masters degree in a field related to STEM.	.85	.73
7.	I would like to pursue a doctoral degree in a STEM-related area.	.77	.60
8.	I am sure that I would like to continue with my education in STEM.	.90	.81
9.	I intend to find a job in STEM.	.94	.88
10.	I can see myself working in STEM.	.95	.91
11.	I am planning on earning a living working in STEM.	.96	.92
12.	I intend to devote my career to an area related to STEM.	.94	.89
	Eigen values	9.88	
	% Variance	80.80	

Note. *Science, Technology, Engineering, and Mathematics. Participants are asked to rate how much they agree with each of the items on a 6- point Likert scale ranging from "very untrue of me" to "very true of me."

Table H2

Means, Standard Deviation, and Correlations of Intent to Persist in STEM ("STEM Intention") Items, N =489

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.0											
2	.90	1.0										
3	.82	.84	1.0									
4	.81	.82	.91	1.0								
5	.71	.71	.78	.82	1.0							
6	.68	.69	.77	.78	.91	1.0						
7	.60	.57	.67	.69	.80	.82	1.0					
8	.76	.76	.81	.82	.78	.76	.73	1.0				
9	.79	.80	.87	.89	.77	.76	.71	.87	1.0			
10	.81	.82	.89	.83	.79	.77	.71	.86	.92	1.0		
11	.80	.80	.90	.90	.80	.78	.73	.87	.93	.94	1.0	
12	.79	.78	.89	.88	.79	.77	.72	.85	.93	.92	.95	1.0
M	3.7	3.6	3.3	3.3	2.9	2.9	2.6	3.2	3.2	3.3	3.2	3.1
SD	1.8	1.8	1.9	1.9	1.7	1.6	1.8	1.9	1.9	1.9	1.9	1.8

Note. All correlations are significant at the <.001 level. Participants are asked to rate how much they agree with each of the following statements (each ending with "an area related to engineering, technology, sciences, or mathematics") on a 6- point Likert scale ranging from "very untrue of me" to "very true of me."

Item 1. Next semester I intend to take courses
Item 2. Next year I intend to take courses
Item 3. I intend to pursue a major
Item 4. I intend to get a Bachelors degree in a major
Item 5. I am planning to apply to a master's degree program in a field
Item 6. I intend to get a masters degree in a field
Item 7. I would like to pursue a doctoral degree in a related area
Item 8. I am sure that I would like to continue with my education
Item 9. I intend to find a job
Item 10. I can see myself working in
Item 11. I am planning on earning a living working in
Item 12. I intend to devote my career to

APPENDIX I

INFORMATION/CONSENT FORM

INFORMATION LETTER
(To be accessed online via the QuestionPRO account)

Hello! My name is Natalie, and I am a doctoral student under the direction of Professor Bernstein in the School of Letters and Sciences. First of all, welcome to your first week as an official ASU sun devil! Also, congratulations on your decision to begin this journey with the University College. The courses available to you through the UC Major and Career Exploration program will help you learn how to best position yourself for success at ASU and beyond.

As you may already know, Arizona State University is a research institution. Research is the process of learning something new about the world by gathering and analyzing of information using a systematic series of steps. Instructors and students are not only at ASU to teach and learn but to create *new* knowledge through scholarly research. Below are examples of research topics that are currently being examined by ASU researchers:

- How to create renewable energy sources
- How to apply social psychological principles to reduce religious conflict
- How to ensure long-term access to clean water supplies for Phoenix area residents
- How to invent technology that can better detect chronic diseases
- How to plan for sustainable urban development
- How to enhance physical therapy with virtual reality software

As you can see, ASU researchers study a wide variety of topics. However, as a scholarly community, we pride ourselves on conducting research that meets practical and social needs of local and global communities.

For assignment # 4 titled “Pen Pal Letter” you will be asked to participate in my dissertation research project, designed to explore the impact of a training delivered over the Internet. This opportunity will be the first of many you will have during your time at Arizona State University to contribute to research as a participant or as the author of your own study.

You will be asked to complete a series of questions. As stated in the UNI 150 syllabus, data collected in this class may be used for research purposes, including the information you submit for as part of this study. Your instructor will not have access to the answers you submit in this study but will be notified once it is complete.

For students who give their permission, data collected in this study will be link to their overall GPA at the end of the Fall 2012 semester. This information will be kept in a password protected, encrypted location. Mary Dawes, the director of the UC academic and career exploration program, will use students’ login information to link grades to the submitted data. She will then be transforming the data into a list that does not contain any identifying information. Granting permission to access your GPA for the purposes of this research study is voluntary and will not affect the credit you will receive for completing this assignment. You can withdraw your consent at any time without penalty.

If you would like to grant permission for the researcher of the study to access your end-of-the-semester grade point average, please check the box below.

☐ ____

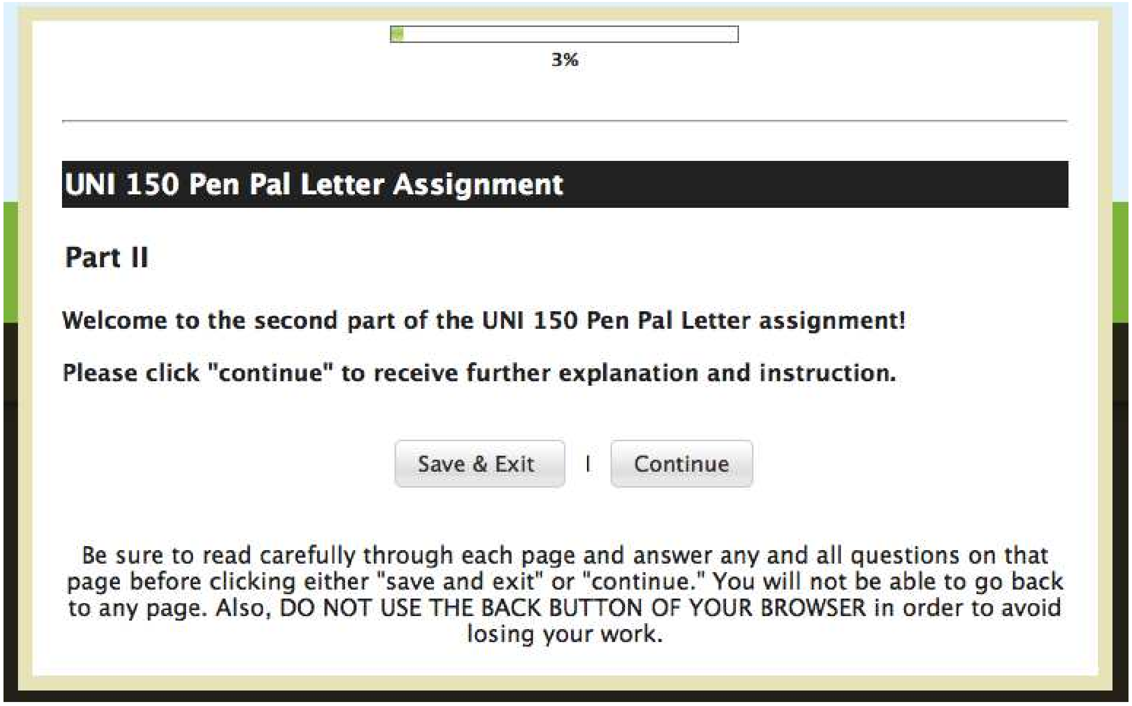
If you have any questions concerning the research study, please contact me at Natalie.Fabert@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

Thank you,

Natalie Fabert, M.Ed.
Doctoral Candidate
School of Letters and Sciences
Arizona State University

APPENDIX J

"PEN PAL" PROGRAM NARRATIVE (PRESENTED TO TREATMENT AND COMPARISON GROUP PARTICIPANTS)


3%
UNI 150 Pen Pal Letter Assignment
Part II
Welcome to the second part of the UNI 150 Pen Pal Letter assignment!
Please click "continue" to receive further explanation and instruction.
Save & Exit
Continue
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

5%

Teachers and administrators of Maricopa County schools have teamed with Arizona State University educational researchers. We are developing a mentoring program designed to connect middle school students with "virtual" mentors. So far, we have created a beta version of the program. Middle school students who seem to be struggling academically and may benefit from mentoring have been identified by parents and teachers. ASU undergraduate students (this means you) will serve as the first "virtual" mentors in this "pilot" study. A "pilot" study is a small, shortened trial of the program in which data is collected to help refine the program.

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work

8%

Overview

• First, you will receive a "pen pal" training. The training will include background information about the mentoring program and the population of middle school students. It will also include tips and research findings to help you learn to be an effective mentor via an online medium. You will be asked to complete true/false and multiple-choice "checkpoint" questions throughout the training to check your understanding of the material. YOU WILL NOT BE ABLE TO RETURN TO PREVIOUS SCREENS BEFORE ANSWERING. If you answer correctly, you will continue moving through the training. If you answer incorrectly, you will receive a review of the previous training section.

• Once you have successfully completed the training, you will be randomly assigned to a middle school student, your "mentee."

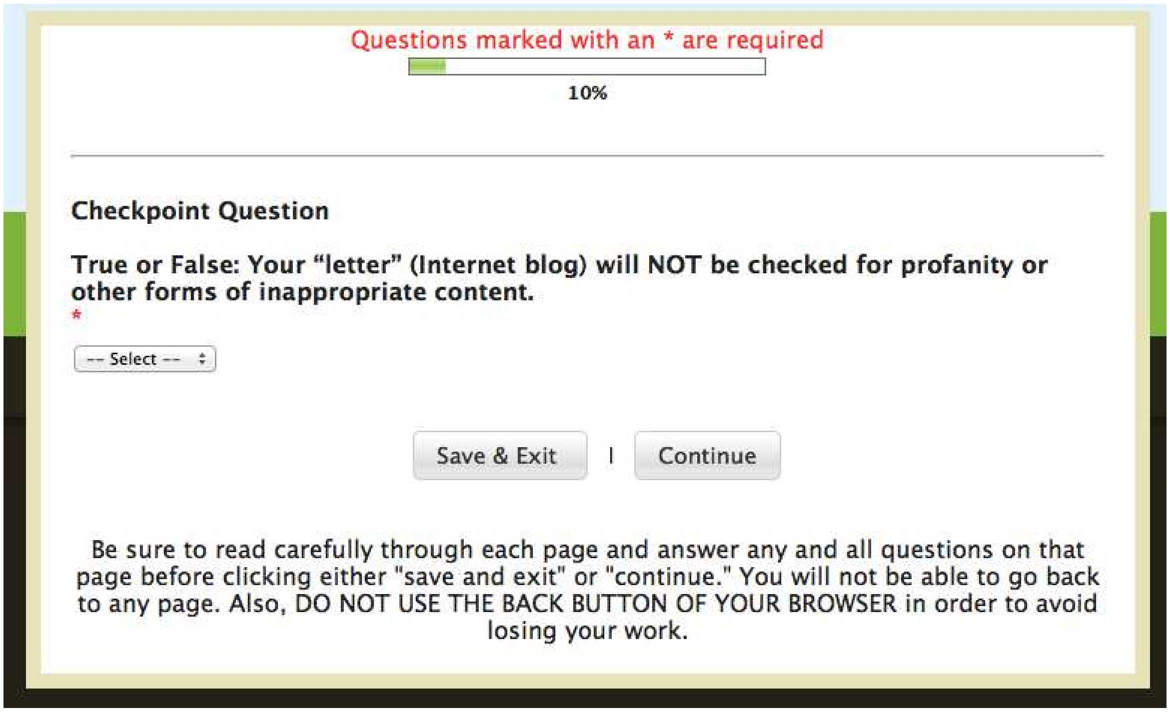
• Basic information about your assigned mentee will be disclosed to you, including his or her first name, age, grade, and reason for referral to the program. Some mentees will have two or more mentors.

• Next, you will create an Internet blog (aka, "letter") of approximately three paragraphs in length that you will submit online. You will only be asked to write one blog to your mentee for the purposes of this pilot study. The content you write in your blog will be kept confidential. However, research assistants will be reading the blogs to ensure that content included is appropriate. Letters that include profanity, discouraging remarks, or other forms of inappropriate content will not be sent.

• After you submit your blog, you will be asked to answer another series of questions to help us better understand the characteristics of our pool of mentors in this pilot study.

• Once you have completed this final series of questions, you will receive a notification of your successful completion of the study. Be sure to save a copy of this notification so that you will receive full credit for your Pen Pal Letter assignment.

Save & Exit | Continue



Questions marked with an * are required

10%

Checkpoint Question

True or False: Your "letter" (Internet blog) will NOT be checked for profanity or other forms of inappropriate content.
*

-- Select --

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Pen Pal Training

Background of My Pen Pal Online Mentoring Program

All children deserve an opportunity to reap the benefits of higher education. Individuals holding a high school diploma make approximately 40% more money compared to individuals without a high school degree (College Entrance Examination Board, 2004). College graduates earn 73% more than high school graduates.

In addition, college graduates:

- Are less likely to be in poverty, unemployed, or imprisoned
- Are more likely to vote and contribute to society
- Are less likely to depend on social services
- Report higher levels of overall health and happiness

Save & Exit | Continue

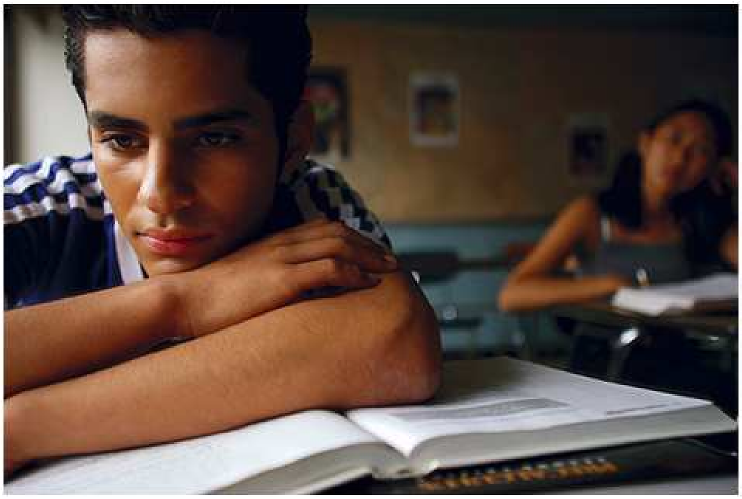
Pen Pal Training: Background

The Population of At-Risk Youth

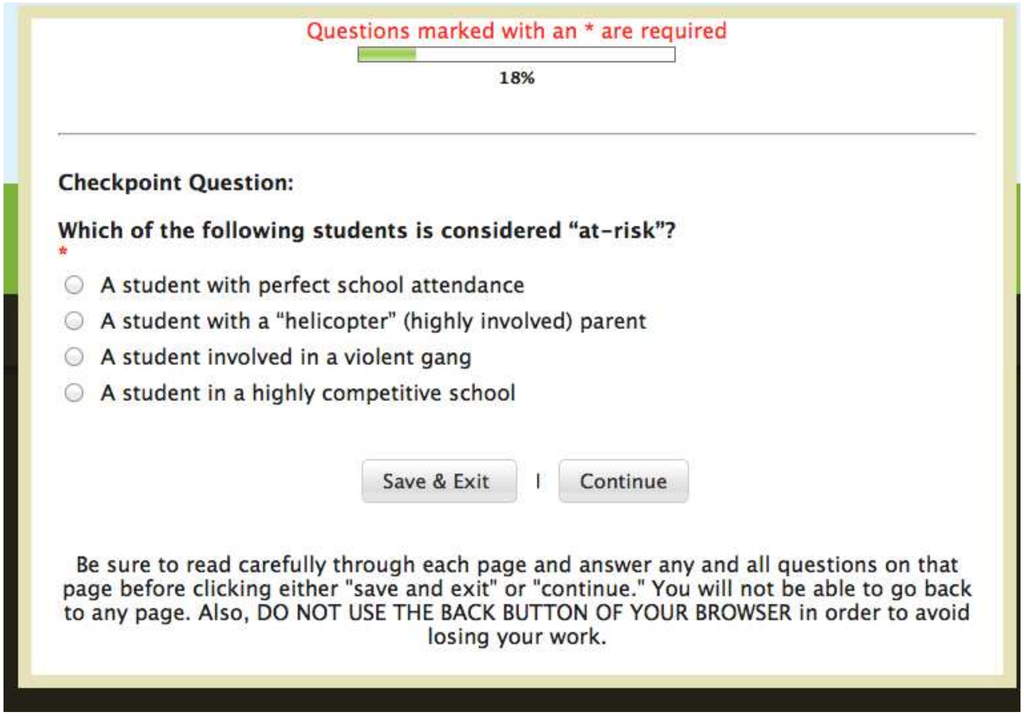
Unfortunately, about 7,000 students drop out of high school everyday. By some estimates, only 7 out of 10 American public high school students actually end up completing high school (National Center for Education Statistics, 2011). The state of Arizona has one of the highest high school drop-out rates in the country.

Certain types of circumstances can make it more difficult for children to do well in school and to achieve the level of educational success that you have so far. These types of circumstances are considered "risk factors," and children with such circumstances are considered "at risk" children. Examples of risk factors include (Hammond, Smink, & Drew, 2007):

- ➢ Poor school attendance
- ➢ Lack of parental guidance
- ➢ Teen pregnancy
- ➢ Juvenile delinquency
- ➢ Lacking access to quality education



Save & Exit | Continue



Questions marked with an * are required

18%

Checkpoint Question:

Which of the following students is considered “at-risk”?
*

- A student with perfect school attendance
- A student with a “helicopter” (highly involved) parent
- A student involved in a violent gang
- A student in a highly competitive school

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

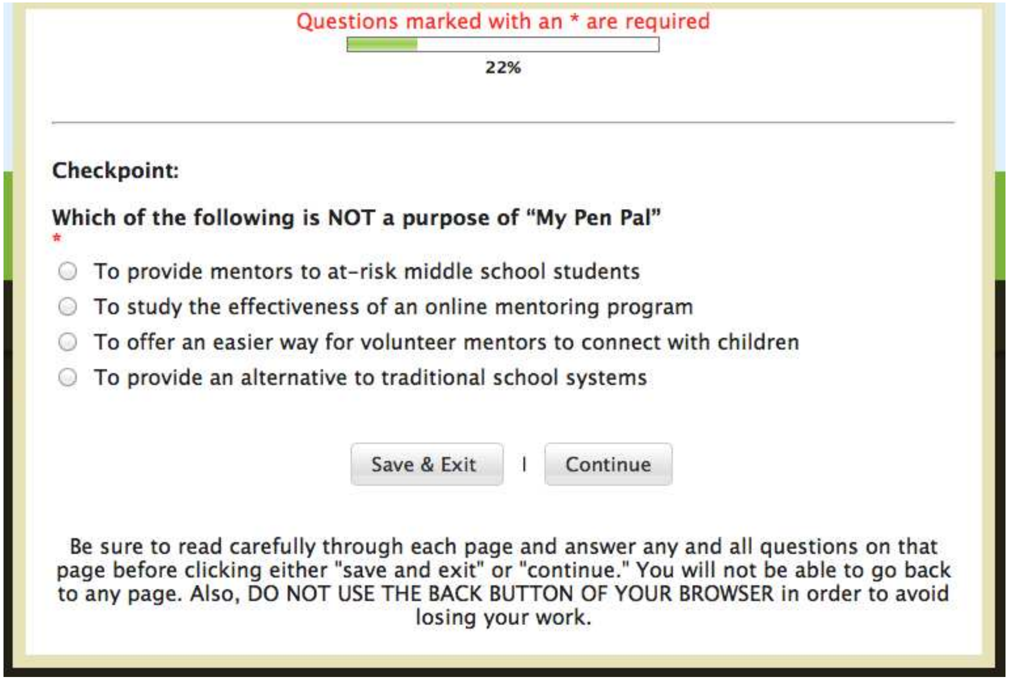
Pen Pal Training: Background

Mentoring, in which an inexperienced individual receives personalized support, encouragement, and guidance from an older, more experienced individual, is one way to help at-risk children achieve in spite of unfavorable odds. Mentoring programs such as Big Brothers Big Sisters have been shown to significantly reduce risk factors such as drug and alcohol use, aggression, and school absenteeism (Tierney & Grossman, 1995; Thompson & Kelly-Vance, 2001). Such programs have also proven to help increase students' academic confidence and achievement. Children with mentors are also known to complete more years of education.

Unfortunately, there are not enough available volunteers to provide in-person mentoring to every at-risk youth. In this research project, we are testing to see whether or not online mentoring programs can be just as helpful as in-person mentoring programs. If so, perhaps we can recruit a larger number of volunteers and serve a larger proportion of the at-risk youth population. After all, children age 8 to 18 spend seven and a half hours a day using electronic devices (NOT counting texting or talking on cell phones)(Lewin, 2010). Electronic media may very well be best way to connect with children and teens.

Academic issues are often first noticed during the pre and early teen years, so we are targeting at-risk, middle school students in this educational intervention.

Save & Exit | Continue



Questions marked with an * are required

22%

Checkpoint:

Which of the following is NOT a purpose of "My Pen Pal"
*

- ○ To provide mentors to at-risk middle school students
- ○ To study the effectiveness of an online mentoring program
- ○ To offer an easier way for volunteer mentors to connect with children
- ○ To provide an alternative to traditional school systems

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

APPENDIX K

"MENTOR TRAINING" RECEIVED BY TREATMENT GROUP PARTICIPANTS

Part of your role as a mentor is to help encourage your mentee to stay motivated in school. Since your assigned mentee will only get one letter from you, it is important to make it as influential as possible.

In the next several pages of this pen pal training, you will receive a review of what psychologists know about how to help increase children's motivation towards learning. The following is an outline of this remaining content:

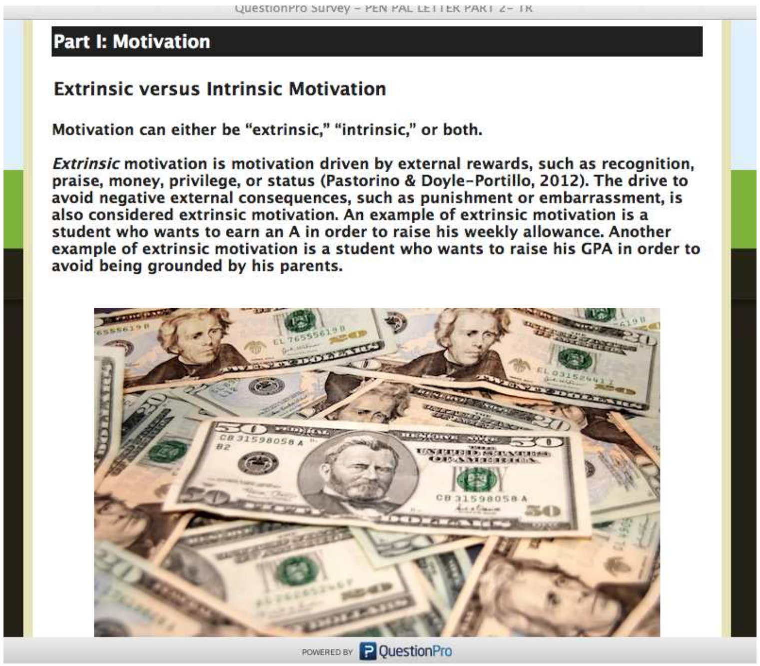
Part I: Motivation
• Extrinsic versus Intrinsic Motivation
• How beliefs about intelligence impact motivation
• How stereotypes about intelligence impact motivation

Part II: Techniques to Increase Intrinsic Motivation
• Emphasize effort, not ability
• Teach children the true nature of intelligence: (It is a muscle that "grows" with practice; Every brain can "grow" to take on new challenges)

Part III: How Learning Physically Changes the Brain
• Brief Brain Biology
• Neuroplasticity (I.Q. can change)
• Neat Facts on Neuroplasticity

Save & Exit | Continue

POWERED BY QuestionPro



QuestionPro Survey – PEN PAL LETTER PART 2– TR

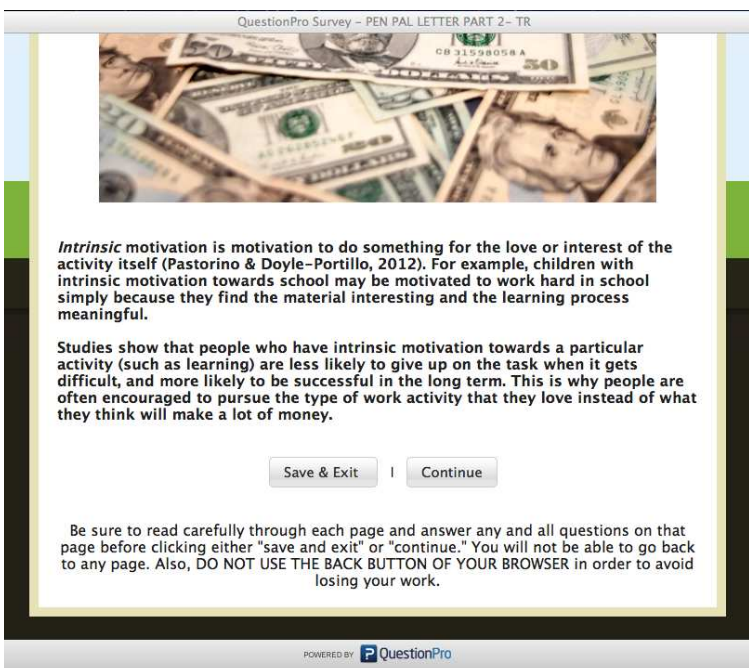
Part I: Motivation

Extrinsic versus Intrinsic Motivation

Motivation can either be "extrinsic," "intrinsic," or both.

***Extrinsic* motivation is motivation driven by external rewards, such as recognition, praise, money, privilege, or status (Pastorino & Doyle-Portillo, 2012). The drive to avoid negative external consequences, such as punishment or embarrassment, is also considered extrinsic motivation. An example of extrinsic motivation is a student who wants to earn an A in order to raise his weekly allowance. Another example of extrinsic motivation is a student who wants to raise his GPA in order to avoid being grounded by his parents.**

POWERED BY QuestionPro



QuestionPro Survey – PEN PAL LETTER PART 2– TR

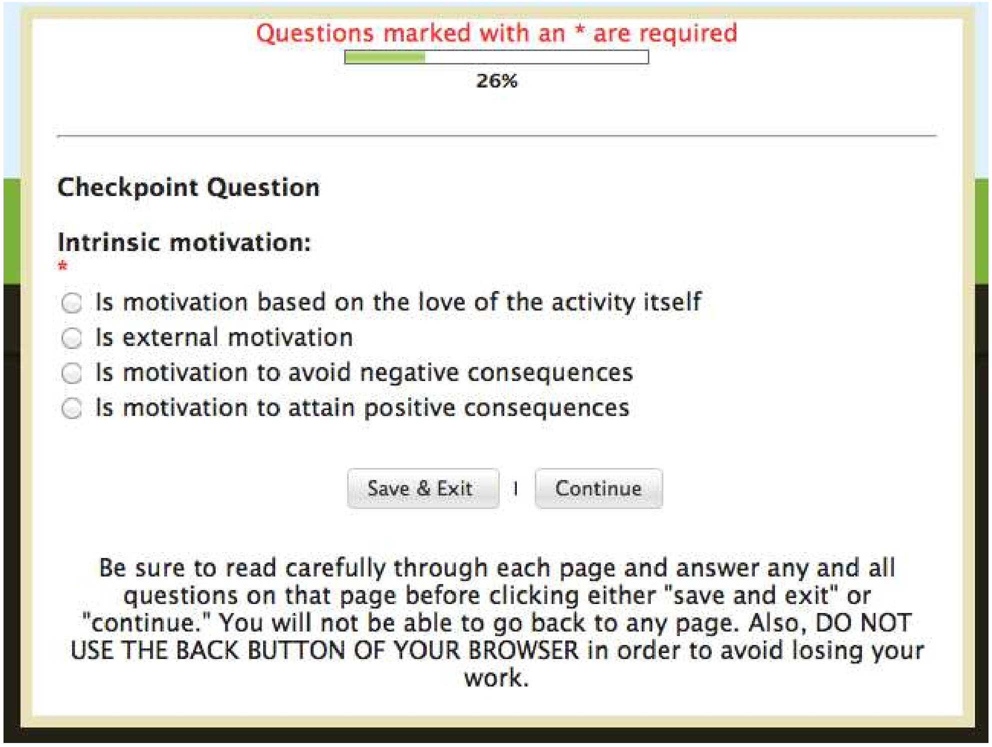
***Intrinsic* motivation is motivation to do something for the love or interest of the activity itself (Pastorino & Doyle-Portillo, 2012). For example, children with intrinsic motivation towards school may be motivated to work hard in school simply because they find the material interesting and the learning process meaningful.**

Studies show that people who have intrinsic motivation towards a particular activity (such as learning) are less likely to give up on the task when it gets difficult, and more likely to be successful in the long term. This is why people are often encouraged to pursue the type of work activity that they love instead of what they think will make a lot of money.

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

POWERED BY QuestionPro



Questions marked with an * are required

26%

Checkpoint Question

Intrinsic motivation:
*

- Is motivation based on the love of the activity itself
- Is external motivation
- Is motivation to avoid negative consequences
- Is motivation to attain positive consequences

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

QuestionPro Survey – PEN PAL LETTER PART 2– TR

Part I: Motivation

How *beliefs* about intelligence impact motivation

Many different factors impact kids' motivation in school, such as how the teacher presents the material, whether or not the student finds the subject interesting, and how "cool" peers consider school to be.

Children's beliefs about intelligence are other examples of such factors that impact motivation towards learning (Dweck, 1999, 1986; Dweck & Leggett, 1988; Hong, Chiu, & Dweck, 1995). Professor Carol Dweck of Columbia and Stanford universities has learned that children tend to hold one of two different beliefs about the nature of intelligence:

1. A belief that intelligence is "fixed":

• These children believe that they are born with a certain amount of intelligence, and that there is nothing they can do to change how inherently "smart" they are.

OR

2. A belief that intelligence can "grow":

• These children believe that intelligence is something that is gained over time by learning about how the world works. They believe that the harder they work at learning something, the more intelligent they will become.

Professor Dweck has studied children with these different types of beliefs about the nature of intelligence. In her studies, she has found that children who have "fixed" beliefs get frustrated when school becomes challenging and give up easily. They tend to have more extrinsic motivation in school, caring only about getting

POWERED BY QuestionPro

QuestionPro Survey – PEN PAL LETTER PART 2– TR

They tend to have more extrinsic motivation in school, caring only about getting answers right and receiving external rewards. These children might chose tasks that make them look "smart" and avoid tasks that appear challenging in order to avoid failing and looking "dumb."

On the other hand, children who believe that intelligence can "grow" see failure as part of the learning process. Therefore, they become less discouraged when they come across failure and are less likely to give up in school. They are intrinsically motivated to work hard in school for the process of learning itself. In fact, they are more likely to elect extra challenging work in order to keep learning. These children are ultimately much more successful in school, Professor Dweck has found.

Save & Exit | Continue

POWERED BY QuestionPro

Questions marked with an * are required

31%

Checkpoint Question:

The difference between the belief that intelligence is "fixed" versus the belief that intelligence can "grow" is:
*

- ○ The belief that intelligence is "fixed" results in less motivation towards learning compared to the belief that intelligence can "grow"
- ○ Children who believe that intelligence can "grow" are less likely to become discouraged in the face of failure compared to children who believe that intelligence is "fixed"
- ○ Both of the answers above
- ○ Nether of the answers above

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

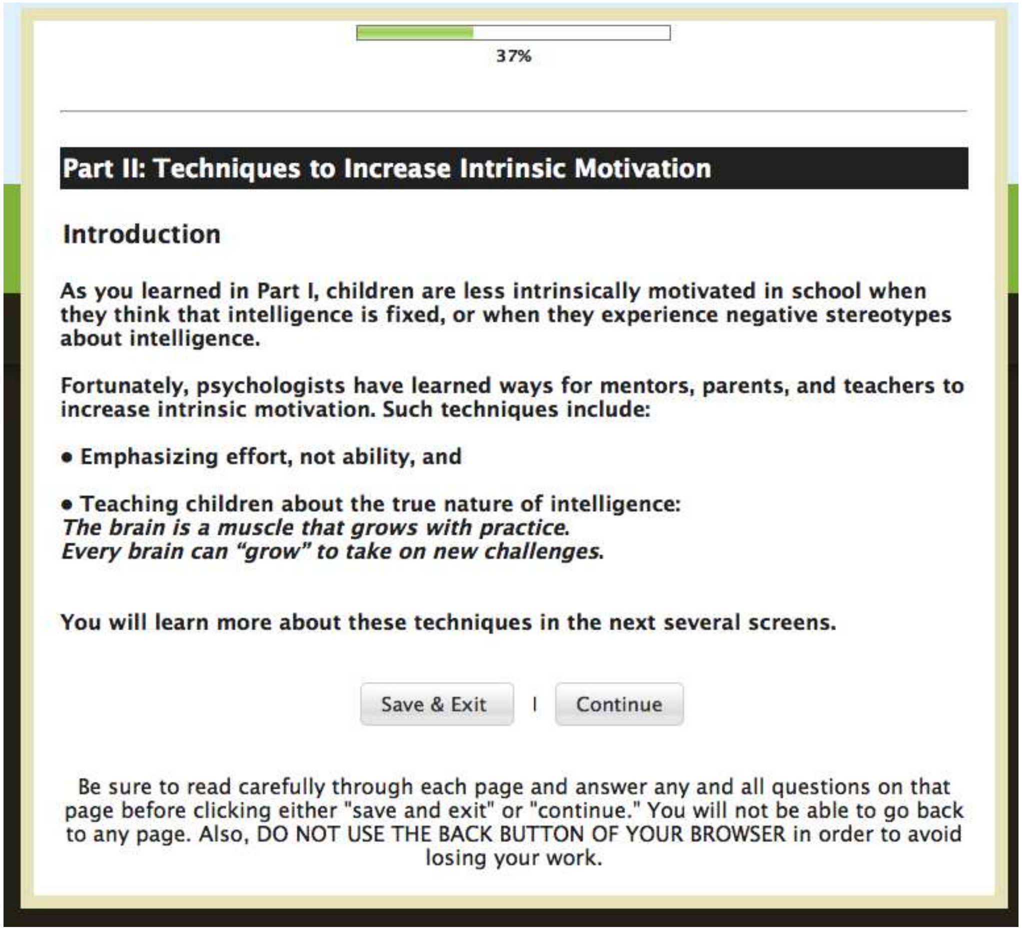
Part I: Motivation

How *stereotypes* about intelligence impact motivation

Stereotypes about abilities also impact children's motivation to work hard in school. A "stereotype" is an assumption about a person based on superficial characteristics of that person. For example, research suggests that people tend to stereotype boys as being better than girls in advanced math courses. "Stereotype threat" is the name for the feeling of anxiety that people sometimes experience when they believe they are being negatively stereotyped (e.g. Steele & Aronson, 1995). When people experience "stereotype threat," they may not be able to perform to the best of their ability and can become discouraged. For example, girls sometimes experience stereotype threat while working on math problems. This experience is one of many reasons why girls sometimes lose interest in taking advanced math courses or going into a major with a lot of math requirements.

Save & Exit | Continue

POWERED BY QuestionPro


37%
Part II: Techniques to Increase Intrinsic Motivation
Introduction
As you learned in Part I, children are less intrinsically motivated in school when they think that intelligence is fixed, or when they experience negative stereotypes about intelligence.
Fortunately, psychologists have learned ways for mentors, parents, and teachers to increase intrinsic motivation. Such techniques include:
• Emphasizing effort, not ability, and
• Teaching children about the true nature of intelligence:
The brain is a muscle that grows with practice.
Every brain can "grow" to take on new challenges.
You will learn more about these techniques in the next several screens.
Save & Exit
Continue
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

40%

Part II: Techniques to Increase Intrinsic Motivation

Emphasize effort, not ability

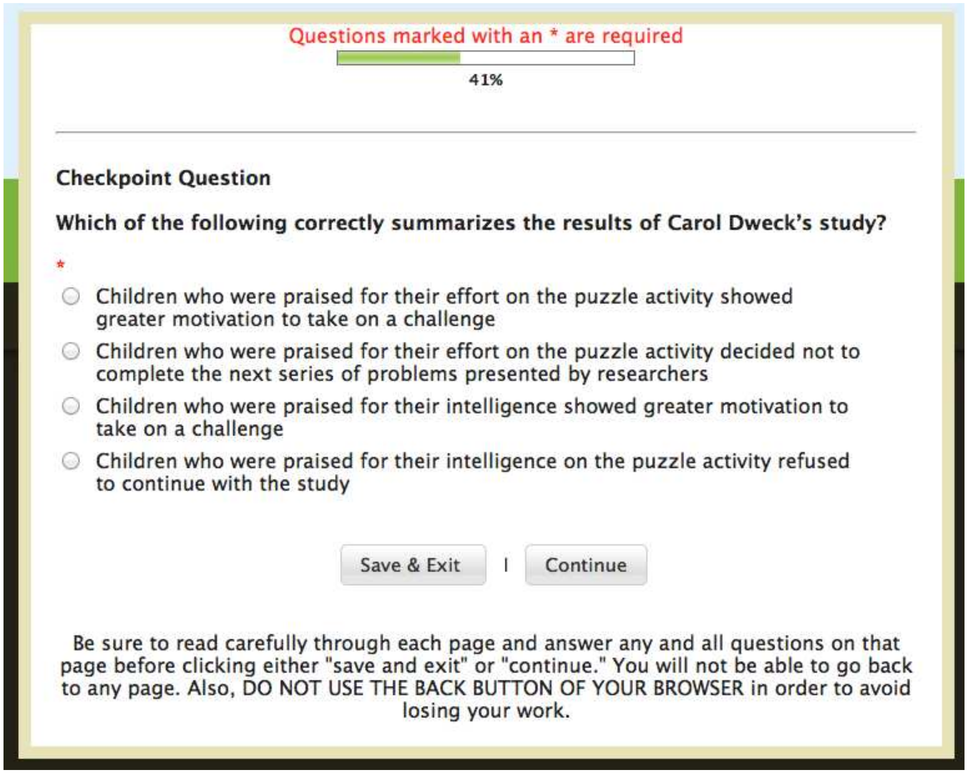
One way to increase intrinsic motivation is to praise children for their effort in school, not for their ability. Parents and teachers used to think it was important to tell kids that they are "smart" or "good" at something in order to build confidence and self-esteem. However, Professor Dweck's research has shown that labeling kids as "smart" does not necessarily motivate them to work hard.

Professor Dweck and her research team at Columbia University recruited 400 children at a local elementary school. Each child was taken into a room by an experimenter and asked to complete a series of puzzles. The puzzles were designed so that most of the children would be able to figure them out easily. After completing the puzzles, half of the children were told by the experimenter "Wow, you must be smart at this!" The other half of the children were told by the experimenter, "Wow, you must have worked very hard!"

Next, the experimenters gave the children a choice between completing a "challenging task full of opportunities to learn" or an "easy task just like the one you have just completed." The majority of the children in the first group (who had been told that they were smart) chose to complete the easy task. The majority of the children in the second group (who had been praised for their effort) opted for the challenging task.

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.


Questions marked with an * are required

41%

Checkpoint Question

Which of the following correctly summarizes the results of Carol Dweck's study?

*

- ○ Children who were praised for their effort on the puzzle activity showed greater motivation to take on a challenge
- ○ Children who were praised for their effort on the puzzle activity decided not to complete the next series of problems presented by researchers
- ○ Children who were praised for their intelligence showed greater motivation to take on a challenge
- ○ Children who were praised for their intelligence on the puzzle activity refused to continue with the study

Save & Exit | Continue

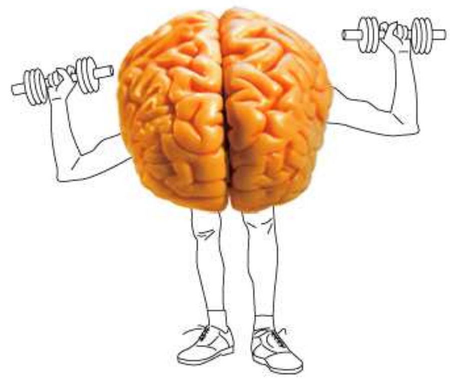
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

44%

Part II: Techniques to Increase Intrinsic Motivation

Teach kids that the brain is a muscle: it grows with practice

Carol Dweck and her research team have created educational interventions that teach children about the biological fundamentals of the learning process. The motto of the training is that the brain is like a muscle: it grows with practice. The interventions successfully change students' "mindsets" towards the learning process. Students learn that intelligence is actually something that can be shaped with experience and learning. They become more excited to learn and perform much better in school.



Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Part II: Techniques to Increase Intrinsic Motivation

Teach kids that every brain can "grow" to take on new challenges

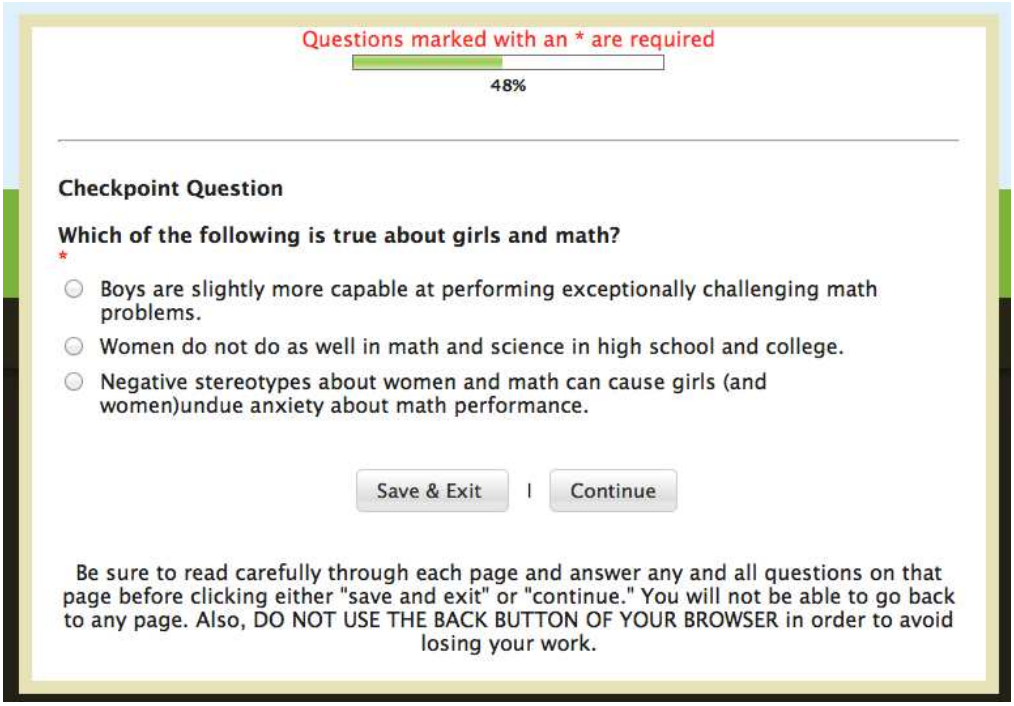
It is also important for children to learn that they can "grow" their brains to take on new challenges, and to be encouraged not to give up on a subject area just because it might be difficult at first. For example, many children quickly decide that math is not their "thing" because it does not come easily to them. In reality, every child can become better at solving math problems with sustained effort and practice. Math and science experts are self-made, not born.

Similarly, it is also important to teach students that stereotypes about intellectual abilities are not true. There is no evidence that different intellectual abilities vary according to sex, race, or ethnicity. According to Professor Spelke at Harvard University,

"...the wealth of research on cognition and cognitive development, conducted over 40 years, provides no reason to believe that the gender imbalances on science faculties, or among physics majors, stem from sex differences in intrinsic aptitude ...mathematical and scientific reasoning develop from a set of biologically based cognitive capacities that males and females share. These capacities lead men and women to develop equal talent for mathematics and science."

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that



Questions marked with an * are required

48%

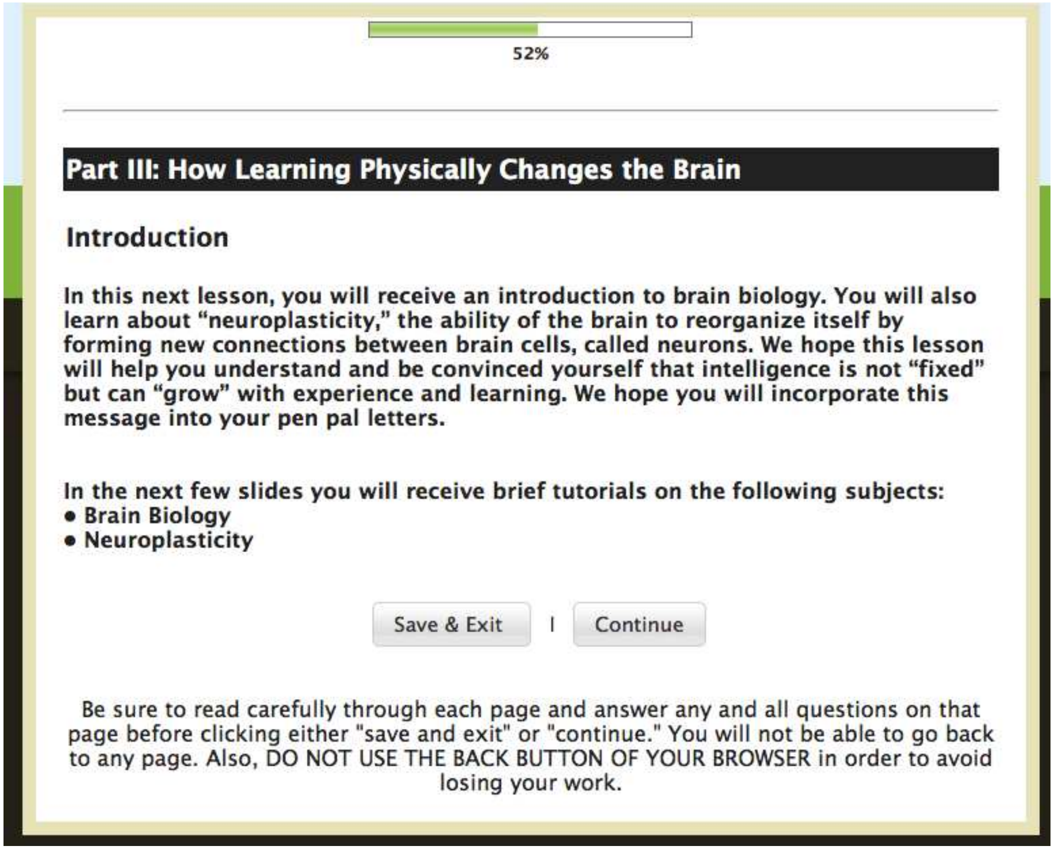
Checkpoint Question

Which of the following is true about girls and math?
*

- ○ Boys are slightly more capable at performing exceptionally challenging math problems.
- ○ Women do not do as well in math and science in high school and college.
- ○ Negative stereotypes about women and math can cause girls (and women)undue anxiety about math performance.

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

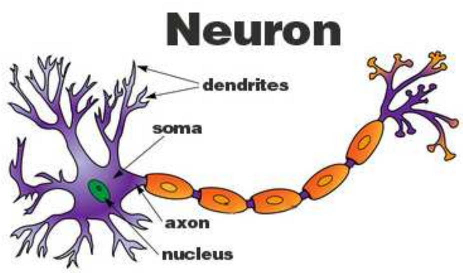

52%
Part III: How Learning Physically Changes the Brain
Introduction
In this next lesson, you will receive an introduction to brain biology. You will also learn about “neuroplasticity,” the ability of the brain to reorganize itself by forming new connections between brain cells, called neurons. We hope this lesson will help you understand and be convinced yourself that intelligence is not “fixed” but can “grow” with experience and learning. We hope you will incorporate this message into your pen pal letters.
In the next few slides you will receive brief tutorials on the following subjects:
• Brain Biology
• Neuroplasticity
Save & Exit
Continue
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Part III: How Learning Physically Changes the Brain

Brief Brain Biology

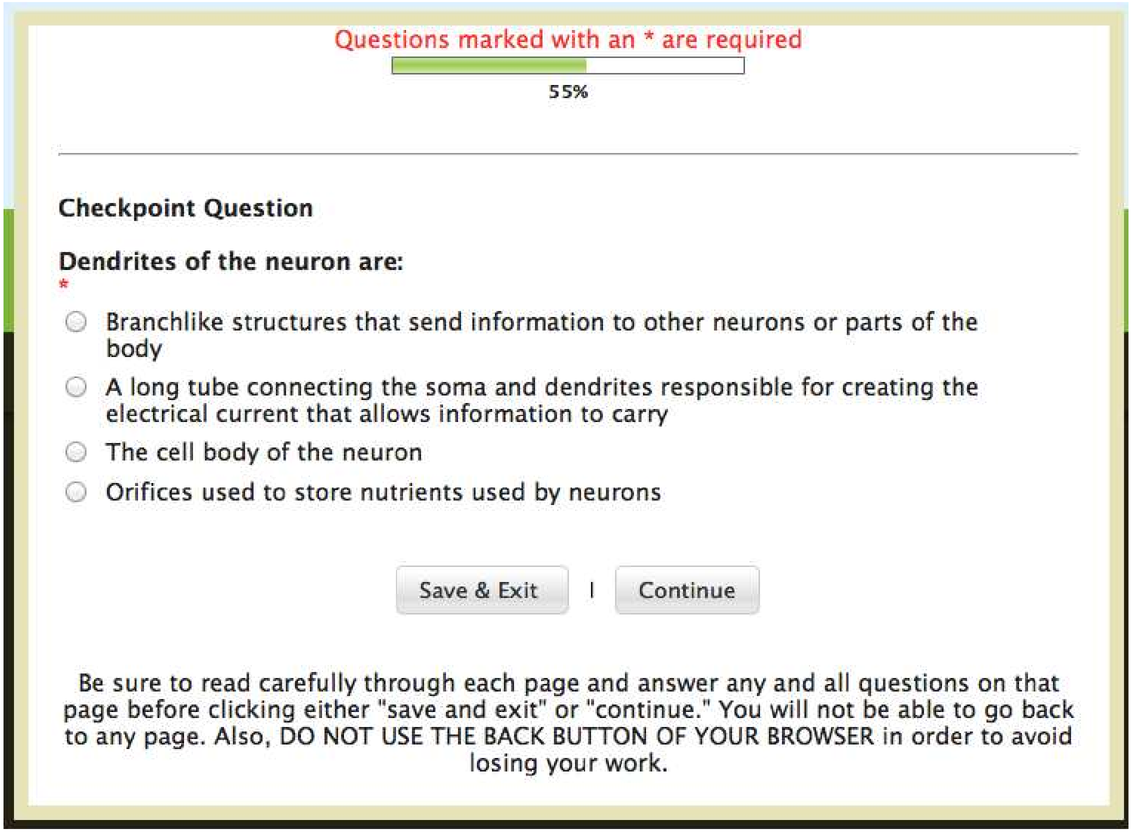
The brain is made of billions of tiny, electrically charged "messengers," called neurons, shown below (Pastorino & Doyle-Portillo, 2012). Neurons send messages to each other and to the rest of the body to operate thoughts, feelings, and reactions. Neurons have all different sizes, shapes, and functions, but they are typically made up of:

- **Soma (cell body),**
- **Dendrites (branchlike structures that send information to other neurons or parts of the body), and**
- **Axon (a long tube connecting the soma and dendrites responsible for creating the electrical current that allows information to carry).**



Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.


Questions marked with an * are required

55%

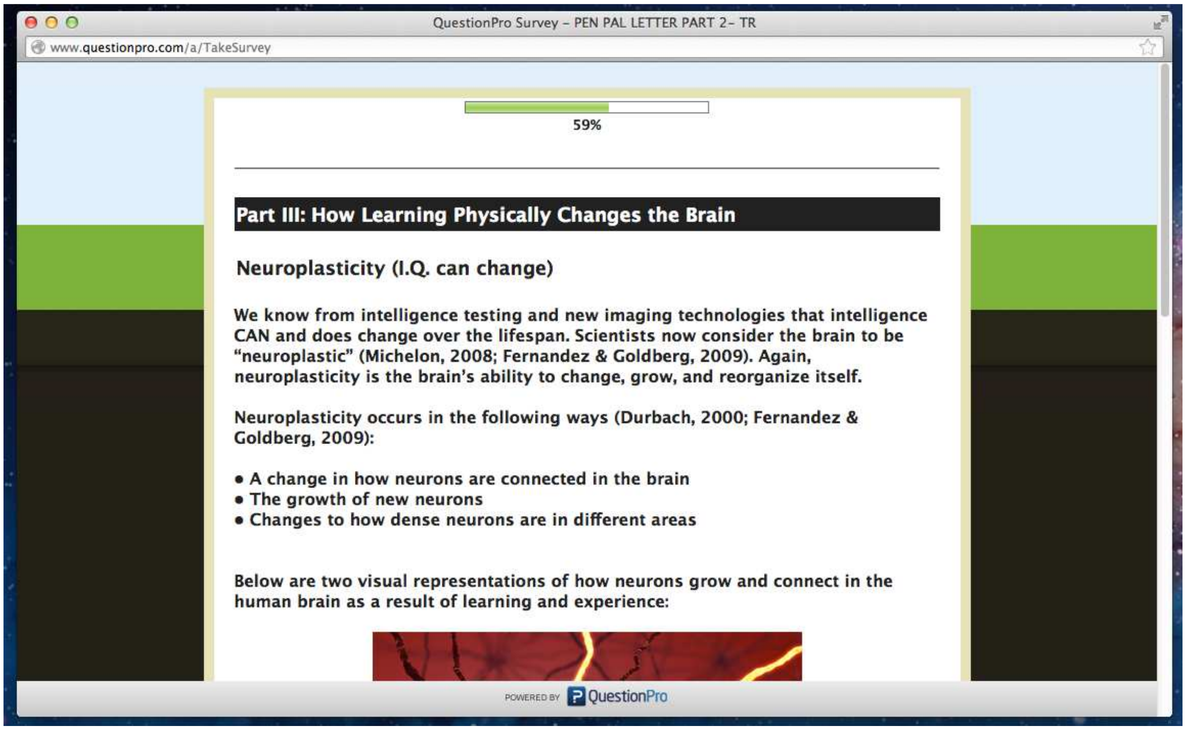
Checkpoint Question

Dendrites of the neuron are:
*

- ○ Branchlike structures that send information to other neurons or parts of the body
- ○ A long tube connecting the soma and dendrites responsible for creating the electrical current that allows information to carry
- ○ The cell body of the neuron
- ○ Orifices used to store nutrients used by neurons

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.



Part III: How Learning Physically Changes the Brain

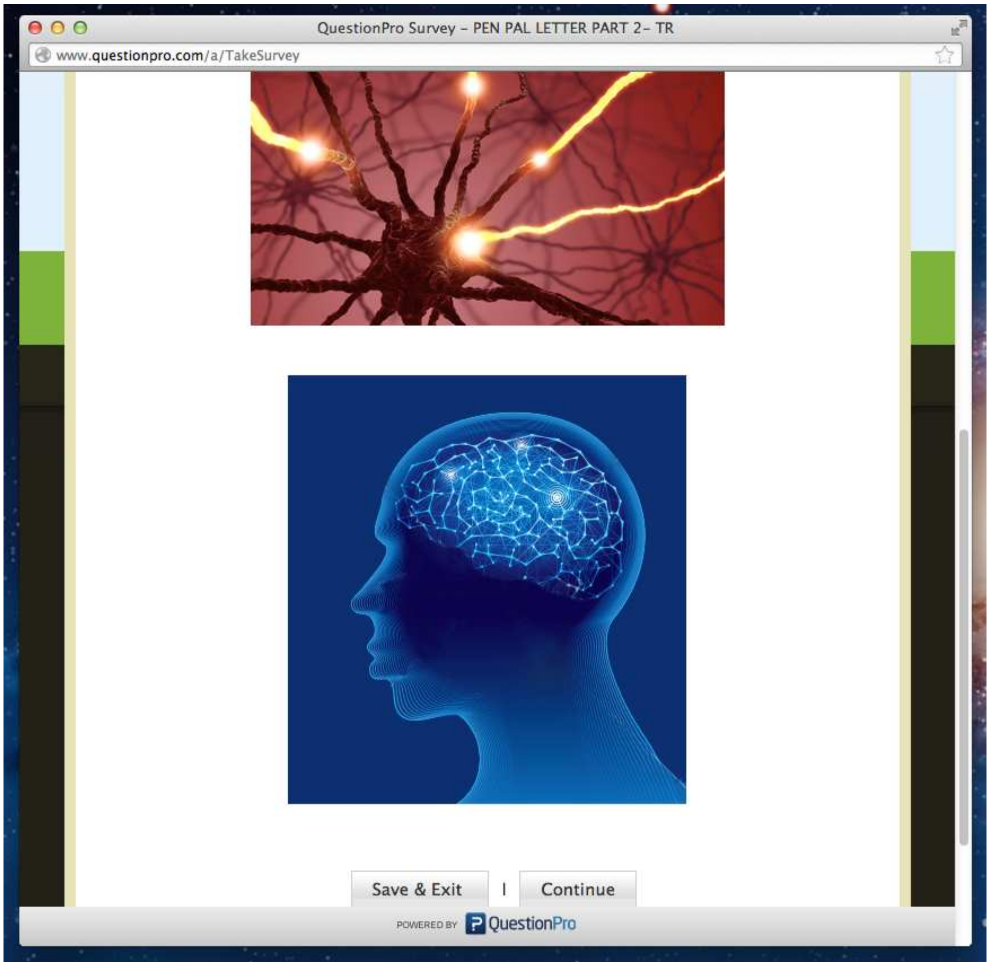
Neuroplasticity (I.Q. can change)

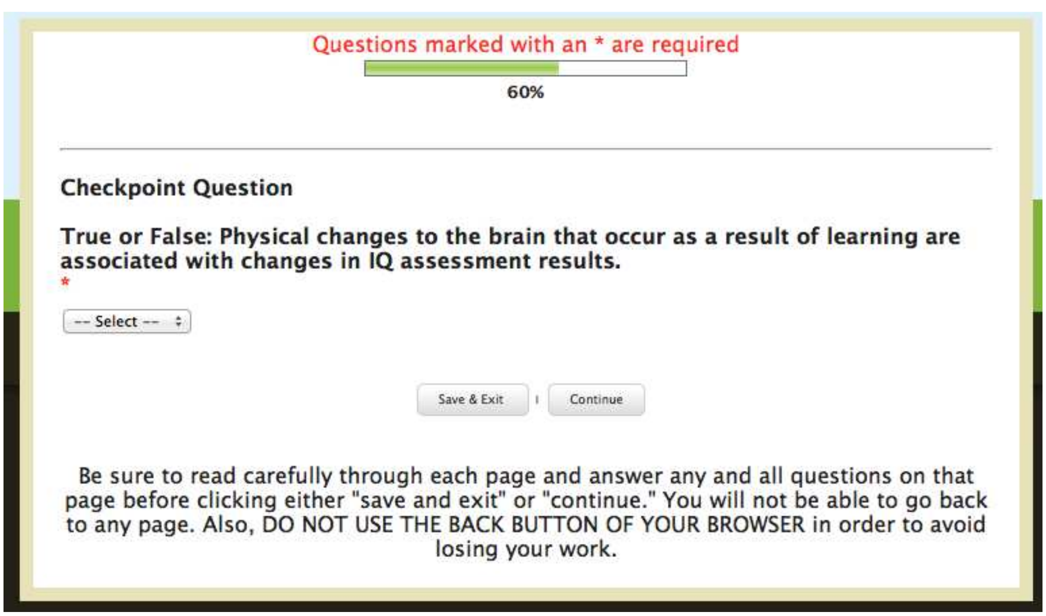
We know from intelligence testing and new imaging technologies that intelligence CAN and does change over the lifespan. Scientists now consider the brain to be "neuroplastic" (Michelon, 2008; Fernandez & Goldberg, 2009). Again, neuroplasticity is the brain's ability to change, grow, and reorganize itself.

Neuroplasticity occurs in the following ways (Durbach, 2000; Fernandez & Goldberg, 2009):

- A change in how neurons are connected in the brain
- The growth of new neurons
- Changes to how dense neurons are in different areas

Below are two visual representations of how neurons grow and connect in the human brain as a result of learning and experience:





Questions marked with an * are required

60%

Checkpoint Question

True or False: Physical changes to the brain that occur as a result of learning are associated with changes in IQ assessment results.
*

-- Select --

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Part III: How Learning Physically Changes the Brain

Neuroplasticity occurs under the following three circumstances (Fernandez & Goldberg, 2009):

1. In the early stages of development, when the brain is starting to build

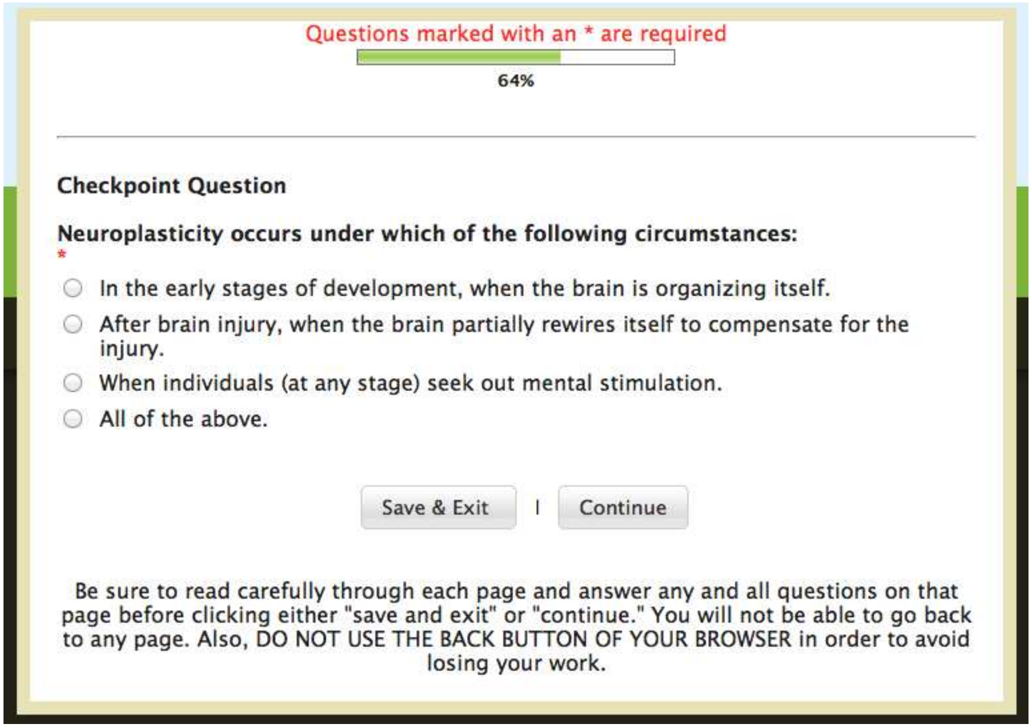
2. After brain injury, when the brain is healing and rewiring itself to compensate for the brain injury

3. When individuals (at any stage) seek out mental stimulation. Mental stimulation occurs in novel (new), challenging, and variety-filled learning situations. Such changes are associated with an increase in IQ-test performance (Ramsden et al., 2011).

Connections between neurons that are not used may eventually be lost through a process called pruning. Thus, learning is like gardening in the sense that individuals make a choice about how to shape their brain by choosing what to learn and experience.

According to Dr. James Zull, Professor of Biology and Biochemistry at Case Western University, *"Learning is physical. Learning means the modification, growth, and pruning of our neurons, connections-called synapses- and neuronal networks, through experience.. When we do so, we are cultivating our own neuronal networks. We become our own gardeners."*

Save & Exit | Continue



Questions marked with an * are required

64%

Checkpoint Question

Neuroplasticity occurs under which of the following circumstances:
*

- In the early stages of development, when the brain is organizing itself.
- After brain injury, when the brain partially rewires itself to compensate for the injury.
- When individuals (at any stage) seek out mental stimulation.
- All of the above.

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Part III: How Learning Physically Changes the Brain

Neat Facts on Neuroplasticity

Below are recent research findings that highlight the brain's neuroplasticity:

• Compared to London bus drivers, London taxi drivers grow larger hippocampi (Maguire, Woollett, & Spiers, 2006). Hippocampi are the parts of the brain that help us understand spatial relations and navigate the environment. Bus drivers tend to go on the same route everyday, so they are not faced with as many new learning experiences as are taxi cab drivers.

• The part of the brain that helps make sense of languages (the left interior parietal cortex) is bigger in bilingual individuals (Mechelli et al., 2004).

• In a recent brain imaging study involving medical school students, it was discovered that the hippocampus (the part of the brain dedicated to memory) grows after studying (Draganski et al., 2006).

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Part III: How Learning Physically Changes the Brain

Neat Facts on Neuroplasticity... continued

• Senior citizens who work to stay mentally, socially, and physically active show less signs of cognitive decline and less signs of dementia compared to senior citizens who stick to old routines (e.g. Snowfon, 1997)

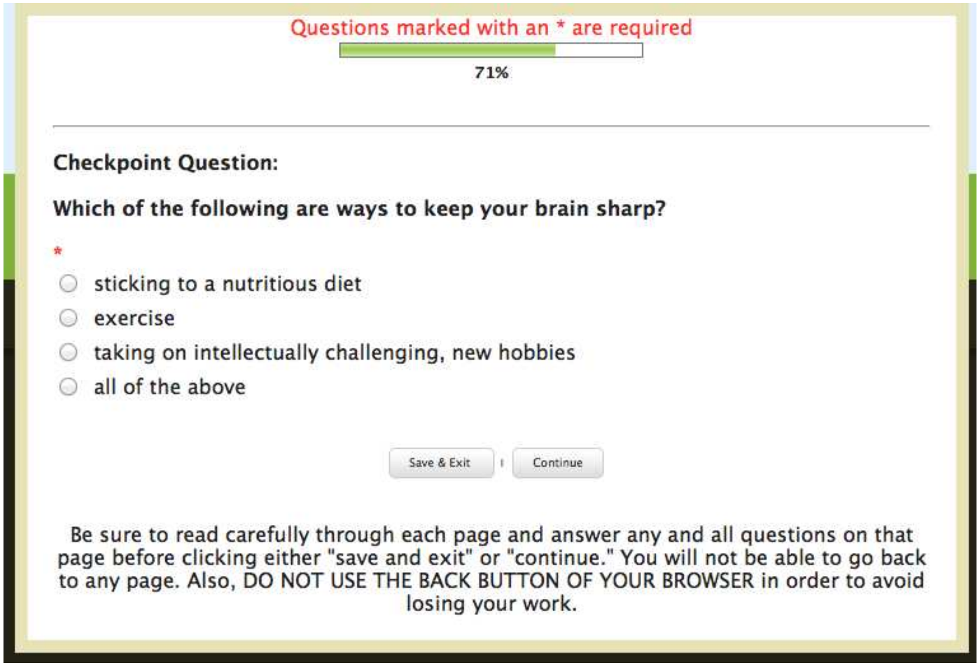
• Rats born in complex environments have denser, more complex brain structures compared to rats born in more simplistic environments, because there is more information about the environment for the rats to learn (Greenough & Chang, 1989)

• Eating a balanced diet, exercising, and managing stress are additional ways known to keep the brain functioning to the best of its ability (Fernandez & Goldberg, 2009)

• The areas of the brain known to be responsible for motor and auditory skills are found to be larger and more complex in musicians compared to non-musicians (Gaser & Schlaug, 2003)

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.


Questions marked with an * are required

71%

Checkpoint Question:

Which of the following are ways to keep your brain sharp?

*

- sticking to a nutritious diet
- exercise
- taking on intellectually challenging, new hobbies
- all of the above

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

APPENDIX L

"MENTOR TRAINING" RECEIVED BY COMPARISON GROUP PARTICIPANTS

Pen Pal Training: How to Motivate Kids

Part of your role as a mentor is to help encourage your mentee to stay motivated in school. Since your assigned mentee will only receive one letter from you for the purposes of this pilot study, it is important to make it as influential as possible.

In this pen pal training, you will gain persuasive writing skills to help you to compose an influential letter to your pen pal. Persuasive writing is writing intended to convince the reader of a particular attitude or message. This training will cover the following main topics relating to persuasive writing skills:

1. Consider your target audience

2. Use the science of social influence by

- Providing "social proof"
- Playing up the reputability of the source
- Arousing emotion

3. Clarify your message by

- Prewriting
- Crafting a compelling line of reason
- Outlining and organizing

Save & Exit | Continue

Persuasive Writing Strategy #1: Consider Your Target Audience

Research shows that individuals pay attention to and think through information best when it appears to be personally relevant (applies to the individual's life in a meaningful way) (Petty & Cacippo 1981). Therefore, the first step in persuasive writing is to consider the characteristics and interests of your target audience, and to think about what might be of particular importance to that audience.

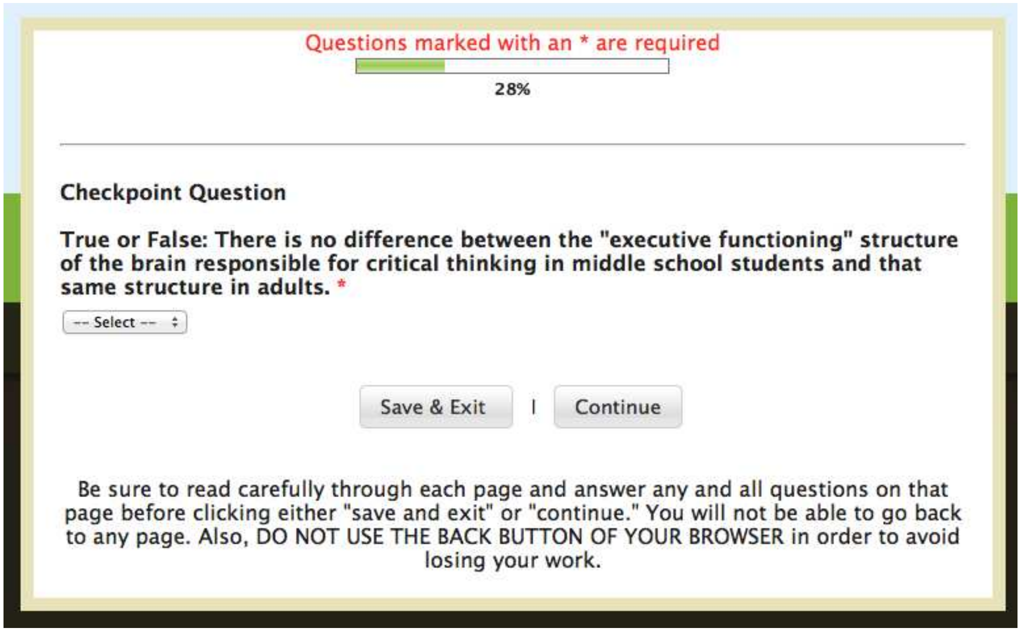
In this case, your letter will be read by an at-risk preteen-aged student. Think back to the time when you were a pre-teen. As a pre-teen, what were your interests, experiences, attitudes, and goals? What types of topics grabbed your attention?

Research suggests that the general population of middle school students is (Scott & Steinberg, 2008; Gerrard et al., 2007):

- **Highly influenced by image and social status**
- **Communicating, socializing, consuming, and seeking out entertainment via electronic media**
- **Undergoing rapid physical and hormonal changes**
- **Still developing the "executive functioning" structures of their brains (responsible for critical thinking and decision-making)**
- **Impulsive and risk-taking**
- **Beginning to explore their personal identities**

Later, you will be receiving a brief description of your assigned middle school student, as well as an explanation for why an instructor referred the student to this program. This information will also help you design your letter to be personally relevant to him or her.

POWERED BY QuestionPro



Questions marked with an * are required

28%

Checkpoint Question

True or False: There is no difference between the "executive functioning" structure of the brain responsible for critical thinking in middle school students and that same structure in adults. *

-- Select --

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Persuasive Writing Strategy #2: Use the Science of Social Influence

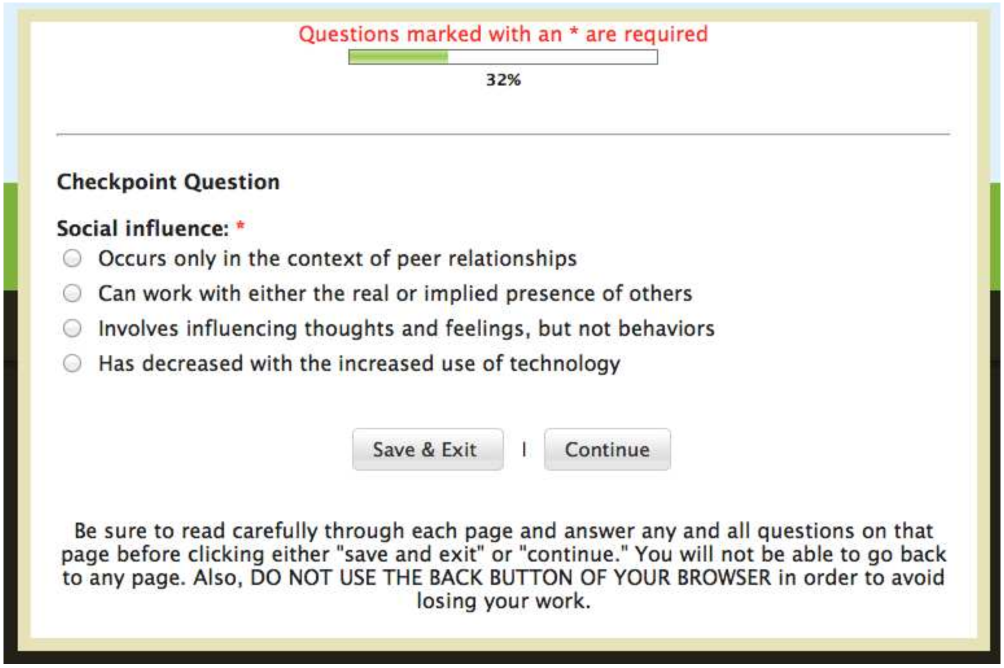
When it comes to influencing the behaviors of others, we can learn a lot from the field of social psychology. One topic studied by social psychologists is social influence, the process through which the real or implied presence of others can directly or indirectly influence the thoughts, feelings, and behavior of an individual.

The three general social influence strategies you will read about in the following slides are to:

- Provide "social proof"
- Play up the reputability of the source
- Arouse emotion

Save & Exit | Continue

POWERED BY QuestionPro


Questions marked with an * are required

32%

Checkpoint Question

Social influence: *

- ◯ Occurs only in the context of peer relationships
- ◯ Can work with either the real or implied presence of others
- ◯ Involves influencing thoughts and feelings, but not behaviors
- ◯ Has decreased with the increased use of technology

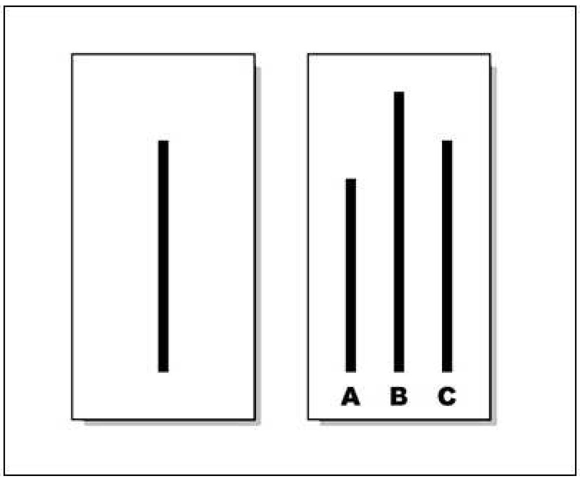
Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Persuasive Writing Strategy #2: Use the Science of Social Influence

by Providing "Social Proof"

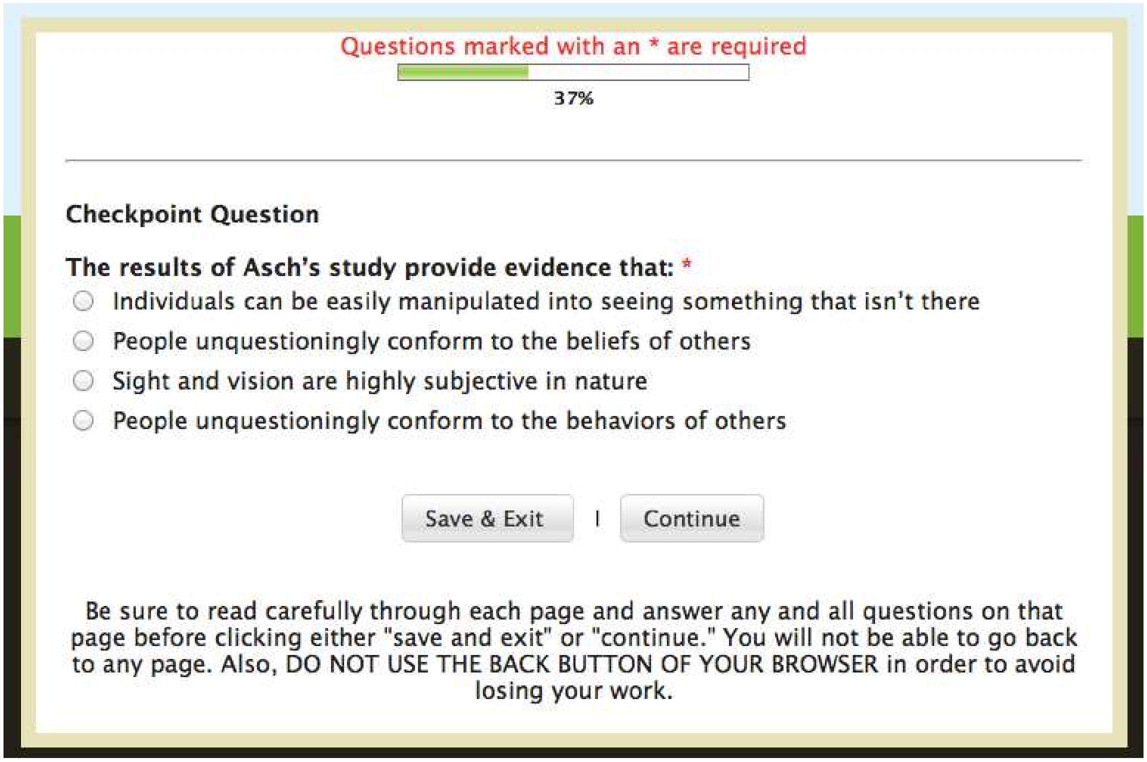
One of the most basic scientific laws of social influence is that people are more likely to think or do something when they believe it is a popular thing to do or think. A famous social psychologist named Solomon Asch presented an extreme example of this law of social influence in a 1951 research study. In this study, participants were invited into a room one by one with a group of "confederates" (individuals who pretend to be naive study participants, but who are actually part of the study and know more information than the true study participants). He presented an image that compared a "sample line" of a particular length with three other lines of varying lengths (shown below). The participants and confederates were asked which of the three lines best matched the length of the sample line.



Although the obvious answer was "c" (as you can see above), the confederates were told ahead of time to respond "b." The confederates answered first. One by one, each confederate in the room answered "b." When it came to be the participant's turn to answer, he or she almost invariably also answered the obviously incorrect answer, "b." These findings supported Asch's initial hypothesis that people easily conform to the opinion of the majority, at least in behavior.

Presenting "social proof" (evidence that a message, product, or behavior is popular or prevalent) is a highly effective social influence technique. In the picture below, McDonald's is using this "social proof" social influence tactic by advertising that billions of people have bought McDonald's product.

Save & Exit | Continue



Questions marked with an * are required

37%

Checkpoint Question

The results of Asch's study provide evidence that: *

- ○ Individuals can be easily manipulated into seeing something that isn't there
- ○ People unquestioningly conform to the beliefs of others
- ○ Sight and vision are highly subjective in nature
- ○ People unquestioningly conform to the behaviors of others

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Persuasive Writing Strategy #2: Use the Science of Social Influence

by Avoiding "Negative Social Proof"

"Negative social proof" refers to evidence that a unwanted behavior is common.

The following examples demonstrate the difference between "positive" and "negative" social proof:

Negative social proof: ***"Despite the known risks of cigarette smoking, thousands of teenagers start smoking cigarettes everyday. When it comes to cigarette smoking, don't be a follower."***

Positive social proof: ***"Due to the known risks of cigarette smoking, the majority of teenagers have decided not to smoke cigarettes. Join the majority of teenagers who abstain from cigarette smoking."***

Negative social proof: ***"Thousands of ASU undergraduates put their lives at risk every weekend by driving drunk."***

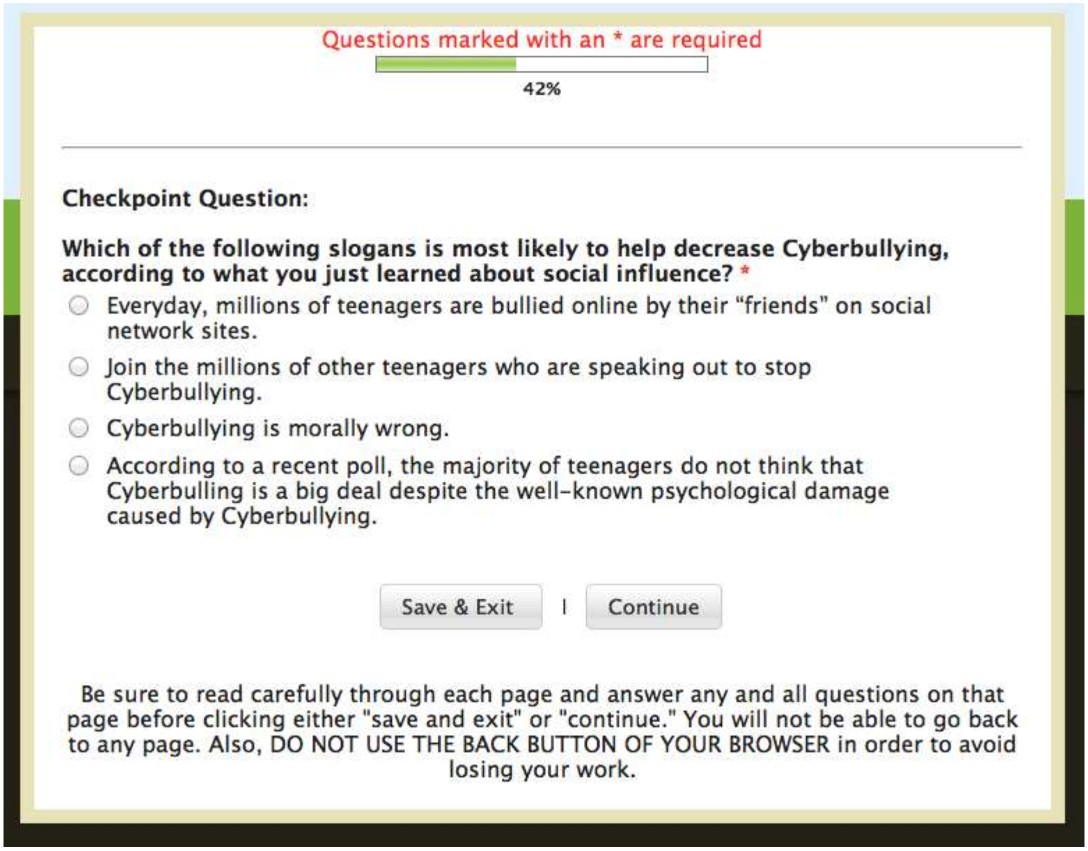
Positive social proof: ***"The majority of ASU students choose to use a designated driver if they choose to drink alcohol."***

Negative social proof: ***"At-risk children are less likely to accomplish professional success in life."***

Positive social proof: ***"Many at-risk children go on to lead successful professional lives despite the many academic barriers they face."***

Positive social proof is more effective than negative social proof (Goldstein et al., 2008; Cialdini, 2001). Negative social proof backfires because people are more likely to do something if they think it is a popular thing to do, even if they are aware of the negative consequences of doing so.

Save & Exit | Continue



Questions marked with an * are required

42%

Checkpoint Question:

Which of the following slogans is most likely to help decrease Cyberbullying, according to what you just learned about social influence? *

- ○ Everyday, millions of teenagers are bullied online by their “friends” on social network sites.
- ○ Join the millions of other teenagers who are speaking out to stop Cyberbullying.
- ○ Cyberbullying is morally wrong.
- ○ According to a recent poll, the majority of teenagers do not think that Cyberbulling is a big deal despite the well-known psychological damage caused by Cyberbullying.

Save & Exit | Continue

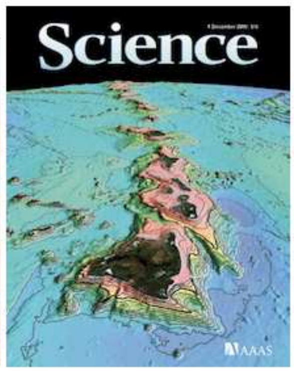
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Persuasive Writing Strategy #2: Use the Science of Social Influence

by Playing Up the Reputability of the Source

Social psychologists who study how to persuade people to change their attitude about something have found that attitude change depends a great deal on the characteristics and reputation of the source that information comes from (such as a parent, teacher, advertisement, magazine, research article, or friend).

For example, you might be more likely to believe a magazine article claiming that life had been discovered on mars if you read it in "Science" magazine than if you had read it in a magazine about UFO sightings.



Save & Exit | Continue

Persuasive Writing Strategy #2: Use the Science of Social Influence

by Playing Up the Reputability of the Source.. continued

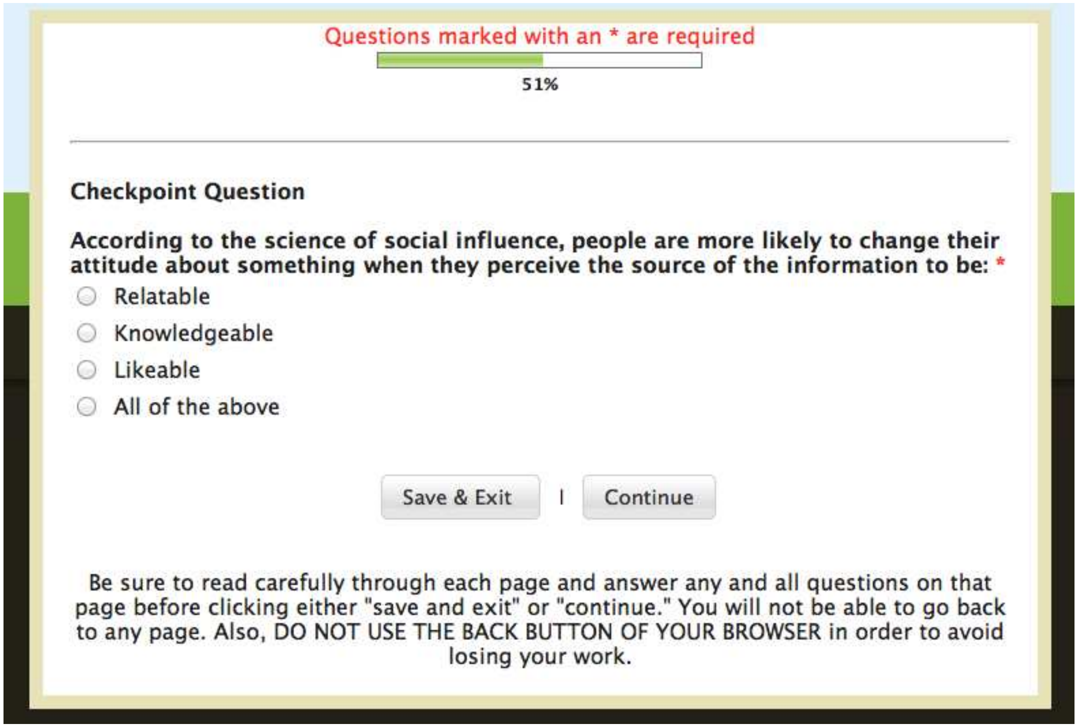
People are more likely to change their attitude about something when they perceive the source of the information is (e.g. Cialdini, 2008; Chaiken, 1980; Petty & Brinol, 2008; Heppner & Claiborn 1989).

- **Trustworthy**
- **Knowledgeable (an "Expert")**
- **Likeable**
- **Relatable**

For example, "Dr. Oz" is considered to be an expert on medicine and health. He has great power in influencing people to change health behaviors and buy certain types of products.

In your pen pal letter, presenting yourself as a knowledgeable, relatable, likeable source of information will help make the letter more powerful. To make yourself sound relatable, you may want to emphasize the experiences you had growing up that are similar to the life experiences of your mentee. To make yourself sound like an expert, be sure to also emphasize your achievements and accomplishments.

Save & Exit | Continue



Questions marked with an * are required

51%

Checkpoint Question

According to the science of social influence, people are more likely to change their attitude about something when they perceive the source of the information to be: *

- Relatable
- Knowledgeable
- Likeable
- All of the above

Save & Exit | Continue

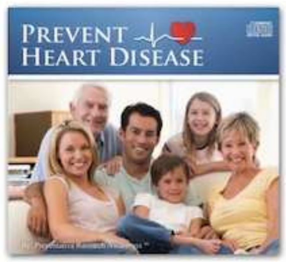
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Persuasive Writing Strategy #2: Use the Science of Social Influence

by Evoking Emotion

"I've learned that people will forget what you said, people will forget what you did, but people will never forget how you made them feel." — Maya Angelou

Evoking emotion is another effective social influence strategy (e.g., Breckler & Wiggins, 1992). Emotional, moving testimonies or personal stories are methods sure to grab the reader's attention. In fact, people are usually more persuaded by personal testimonies than by numbers and statistics. Knowing how to evoke emotion involves knowing topics of personal relevance to your target audience (the first persuasive writing technique you learned about in this training). Think of pharmaceutical advertising targeted at the elderly population. A common narrative in these commercials is of an elderly man or woman surrounded by spouses, children, and grandchildren. The advertisers are intending to pull at the heartstrings of their target audience.

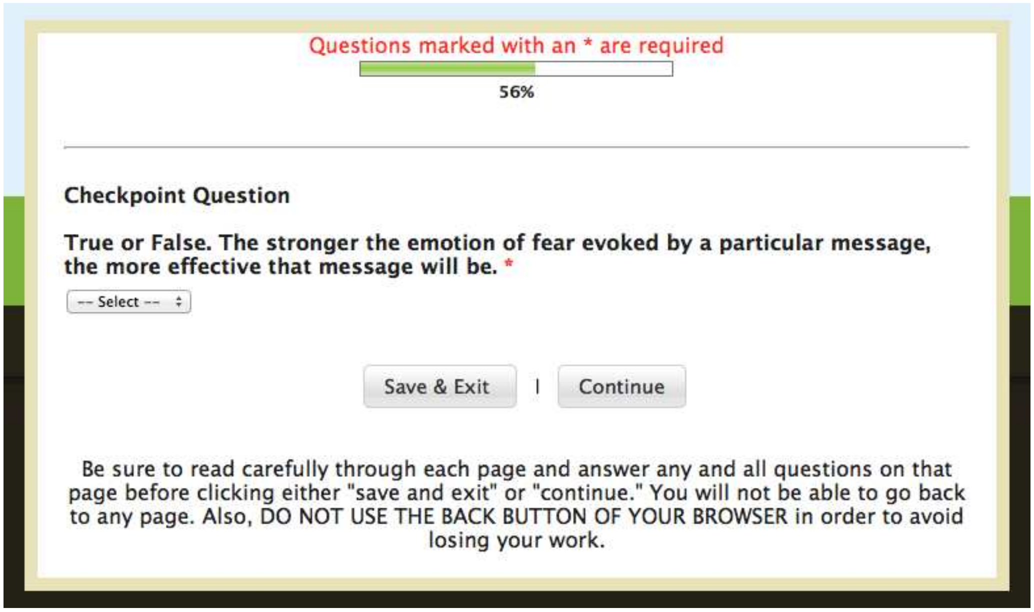


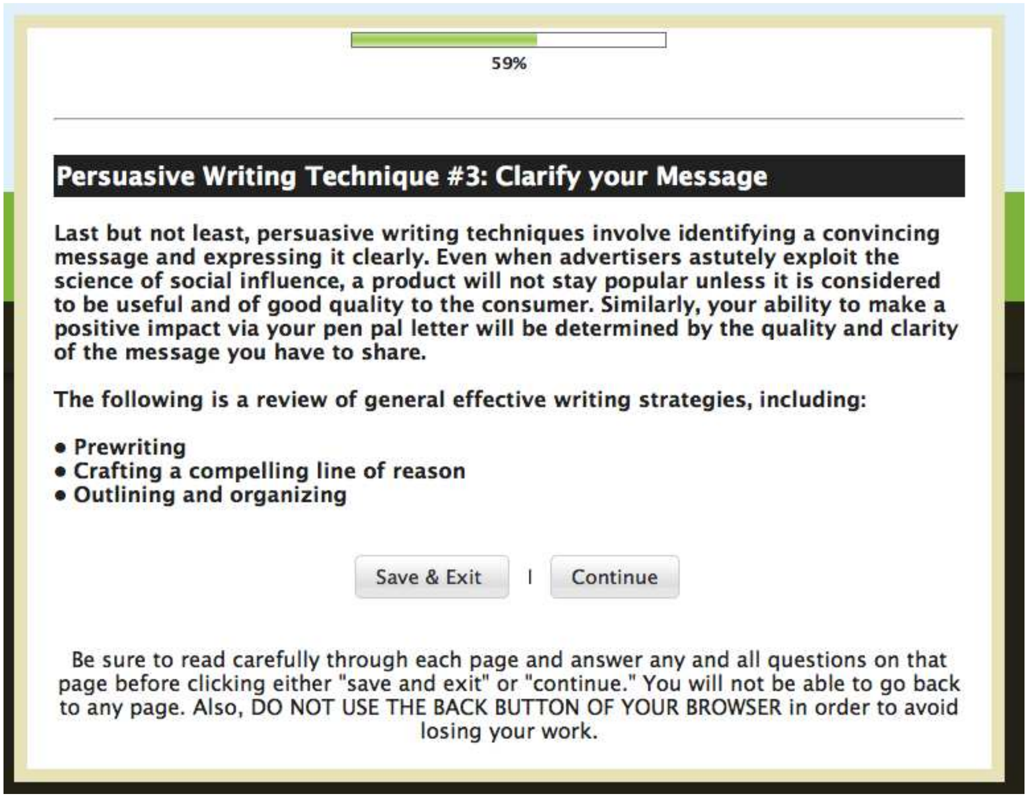
Research suggests that the teenage population tends to be particularly motivated by feelings of belongingness and are highly sensitive to feelings of social anxiety.

Research suggests that evoking the following emotions tend to be particularly influential for individuals across ages and cultures:

- **Humor**
- **Fear**
- **Loss**
- **Affection**
- **Disgust**

Warning: Be careful when evoking the emotion of fear. Whereas a moderate amount of fear can be a very motivating factor, evoking too much fear causes individuals to disengage and ignore the information being provided. This is perhaps why techniques that try to "scare kids straight" from, for example, drug abuse or sexually promiscuous behavior often backfire.


Questions marked with an * are required
56%
Checkpoint Question
True or False. The stronger the emotion of fear evoked by a particular message, the more effective that message will be. *
-- Select --
Save & Exit
Continue
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.


59%
Persuasive Writing Technique #3: Clarify your Message
Last but not least, persuasive writing techniques involve identifying a convincing message and expressing it clearly. Even when advertisers astutely exploit the science of social influence, a product will not stay popular unless it is considered to be useful and of good quality to the consumer. Similarly, your ability to make a positive impact via your pen pal letter will be determined by the quality and clarity of the message you have to share.
The following is a review of general effective writing strategies, including:
• Prewriting
• Crafting a compelling line of reason
• Outlining and organizing
Save & Exit
Continue
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

Persuasive Writing Strategies: Clarify your Message

by Prewriting

The most important but most often skipped step in writing is prewriting.

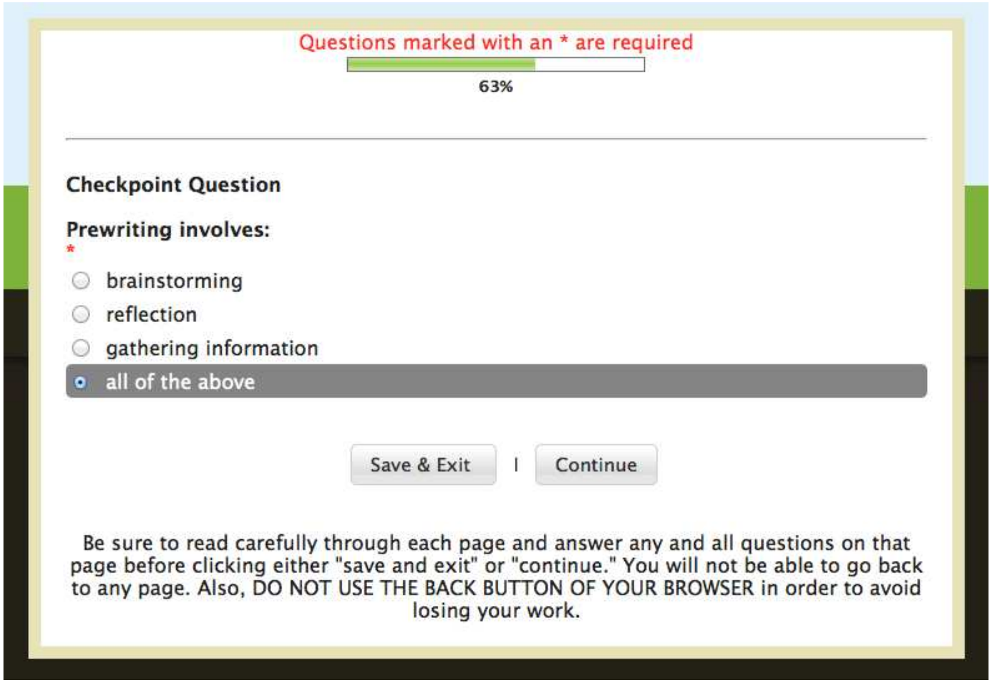
For this pen pal assignment, prewriting might start with reflection and brainstorming. Take down notes about anything that comes to mind that you might want to include in your letter. Jot down even outrageous-sounding ideas for now. Allow your creative juices to flow.

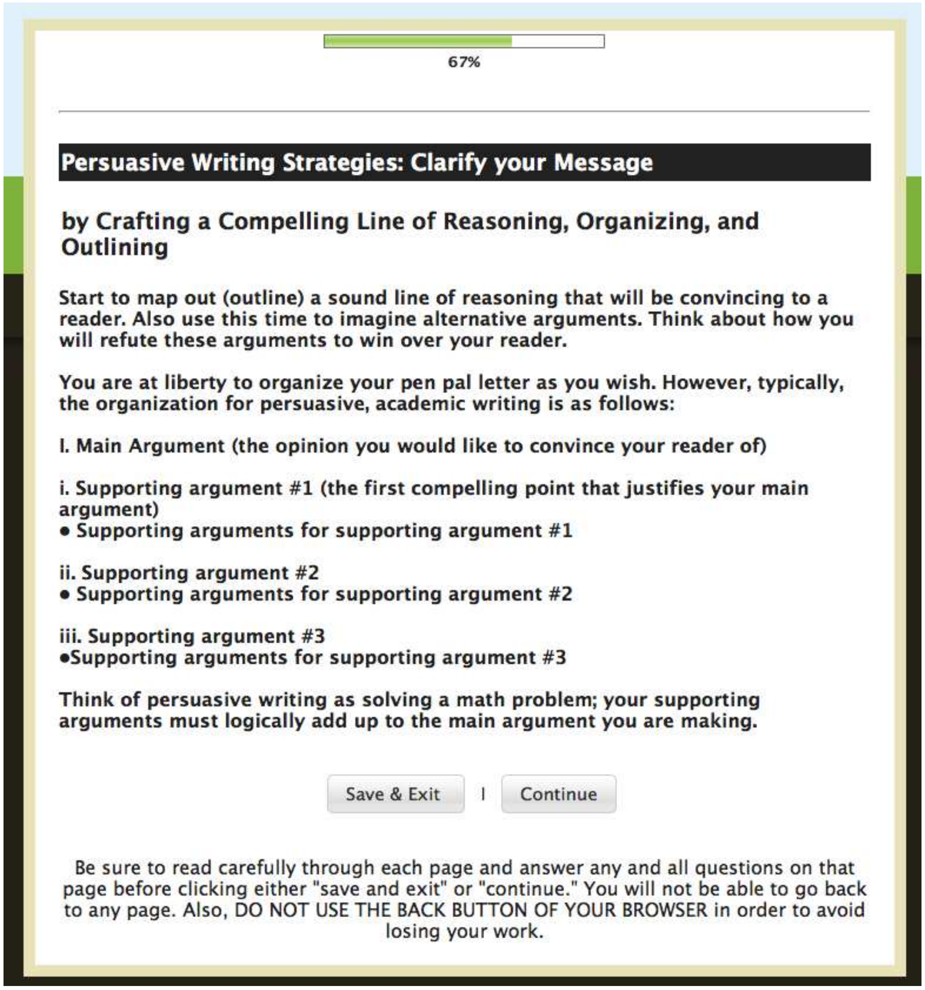
For more traditional papers and class assignments, prewriting will also involve gathering information (by, for example, reading assigned texts and articles and researching missing information) so that you have a command of the topic you are to write about.

Eventually, you will start to hone in on your main argument or opinion. Some of the ideas you jotted down while brainstorming might be part of the argument, while others may be unrelated and can be disposed.

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.


Questions marked with an * are required
63%
Checkpoint Question
Prewriting involves:
*
brainstorming
reflection
gathering information
all of the above
Save & Exit
Continue
Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.



67%

Persuasive Writing Strategies: Clarify your Message

by Crafting a Compelling Line of Reasoning, Organizing, and Outlining

Start to map out (outline) a sound line of reasoning that will be convincing to a reader. Also use this time to imagine alternative arguments. Think about how you will refute these arguments to win over your reader.

You are at liberty to organize your pen pal letter as you wish. However, typically, the organization for persuasive, academic writing is as follows:

I. Main Argument (the opinion you would like to convince your reader of)

i. Supporting argument #1 (the first compelling point that justifies your main argument)
• Supporting arguments for supporting argument #1

ii. Supporting argument #2
• Supporting arguments for supporting argument #2

iii. Supporting argument #3
•Supporting arguments for supporting argument #3

Think of persuasive writing as solving a math problem; your supporting arguments must logically add up to the main argument you are making.

Save & Exit | Continue

Be sure to read carefully through each page and answer any and all questions on that page before clicking either "save and exit" or "continue." You will not be able to go back to any page. Also, DO NOT USE THE BACK BUTTON OF YOUR BROWSER in order to avoid losing your work.

APPENDIX M

EXAMPLE FEEDBACK PAGE FOLLOWING AN INCORRECT QUIZ ANSWER

That is incorrect. Intrinsic motivation is motivation based on the love of the activity itself.

Below is a copy of the section on extrinsic and intrinsic motivation for your review:

Part I: Motivation
Extrinsic versus Intrinsic Motivation

Children vary to the extent that they are motivated to succeed in school. Motivation can either be "extrinsic," "intrinsic," or both.

Extrinsic motivation is fueled by external rewards, such as recognition, praise, money, privilege, or status. Extrinsic motivation is also fueled by negative external consequences, such as punishment or embarrassment. An example of extrinsic motivation is a student who wants to earn an A in order to raise his weekly allowance. Another example of extrinsic motivation is a student who wants to raise his GPA in order to avoid being grounded by his parents.

Intrinsic motivation is motivation to do something for the love or interest of the activity itself. For example, children with intrinsic motivation towards school may be motivated to work hard in school simply because they find the material interested and the learning process meaningful.

Studies show that people who have intrinsic motivation towards a particular activity (such as learning) are less likely to give up on the task when it gets difficult, and more likely to be successful in the long term. This is why people are often encouraged to pursue the type of work activity that they love instead of what they think will make a lot of money.

Save & Exit | Continue

APPENDIX N

MENTEE PROFILES RANDOMLY ASSIGNED TO PARTICIPANTS

Below is information about your assigned pen pal.

Name: Anna
Grade: 7th
Gender: Female
School: Orangewood School (Elementary and Middle School), Washington School District.

Reason for referral: ***Anna is a sweet l2 year old 7th grade girl who seems to be slipping in her coursework. According to Anna's fifth and sixth grade teachers, she used to love math courses and was one of the highest achieving math students. During a 6th grade field trip to the ASU Polytechnic campus, Anna became interested in studying alternative energy. She researched the electronic engineering technology major at ASU for her assignment on the field trip experience. I have not heard Anna talk about engineering much at all this year or about her thoughts on attending college. Pre-algebra started out as a struggle for Anna, as it does for many students, and she seems to be giving up completely.***

- 7th grade Orangewood pre-algebra teacher

PROMPT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

Below is information about your assigned pen pal.

Name: Trevor
Grade: 8th grade
Age: 13
School: Mountain View school, Washington Elementary School District #6

Reason for referral: *Trevor was in my pre-algebra class at Mountain View last year as a 7th grader. I decided to refer Trevor to this program because I believe he needs as much encouragement as possible to help him stay motivated in his 8th grade algebra class. I have noticed that he gets easily frustrated if he does not understand concepts right away. His grades were slipping towards the end of his seventh grade class. Instead of redoubling his efforts, he became more disengaged with the pre-algebra material. I was on the fence as to whether or not to recommend that he repeat pre-algebra. Ultimately, I decided to move him forward to 8th grade algebra. However, I am a little concerned about how he will perform.*

- 7th grade teacher

PROMPT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

Below is information about your assigned pen pal.

--

Name: Melissa
Grade: 8th grade
Age: 13
School: Desert Wind Middle School, Maricopa Unified School District

Reason for referral: ***Melissa was in my pre-algebra class at Desert Wind last year as a 7th grader. I decided to refer Melissa to this program because I believe she needs as much encouragement as possible to help her stay motivated in her 8th grade algebra class. I have noticed that she gets easily frustrated if she does not understand concepts right away. Her grades were slipping towards the end of her seventh grade class. Instead of redoubling her efforts, she became more disengaged with the pre-algebra material. I was on the fence as to whether or not to recommend that she repeat pre-algebra. Ultimately, I decided to move her forward to 8th grade algebra. However, I am a little concerned about how she will perform.***

- 7th grade pre-algebra teacher

--

PROMPT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

Below is information about your assigned pen pal.

Name: Eric
Grade: 7th
Gender: Male
School: Orangewood School (Elementary and Middle School), Washington School District.

Reason for referral: ***Eric is a sweet l2 year old 7th grade boy who seems to be slipping in his coursework. According to Eric's fifth and sixth grade teachers, he used to love math courses and was one of the highest achieving math students. During a 6th grade field trip to the ASU Polytechnic campus, he became interested in studying alternative energy. He researched the electronic engineering technology major at ASU for his assignment on the field trip experience. I have not heard him talk about engineering much at all this year or about his thoughts on attending college. Pre-algebra started out as a struggle for Eric, as it does for many students, and he seems to be giving up completely.***

- 7th grade Orangewood pre-algebra teacher

PROMPT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. You will not be able to go back to this screen. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

Below is information about your assigned pen pal.

Name: Samantha
Grade: 8th grade
Age: 13
School: Maricopa Wells Middle School

Reason for Referral: ***I referred Samantha to this program because I believe she has a lot of potential in school and could use some extra encouragement. I worked with Samantha in both 6th and 7th grades. Unfortunately, I have a class size of 30 students and no extra help, so I am not able to give students the individual attention that they deserve. Samantha seems to love working with computers and designing websites. She volunteered to create a class website to help students keep up with their homework assignments. I have overheard Samantha telling other students that she would like to be a graphic designer like her uncle. She is a pretty good student but struggles in certain subjects, like math. As far as I know, graphic design programs require a certain level of math coursework. Samantha is now in 8th grade and struggling in pre-algebra. My hope for Samantha is not to give up in math so that she can keep her career options open as long as possible.***

- 7th grade instructor at Maricopa Wells Middle School

PROMPT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. You will not be able to go back to this screen. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

Below is information about your assigned pen pal.

--

Name: Nick
Age: 13
Grade: 8th
School: Desert Wind Middle School, Maricopa Unified School District #20

Reason for referral: ***I decided to refer one of my previous students, Nick, to this program in hopes that it will provide him with some extra encouragement during the transition period between middle school and high school. Nick's parents are incredibly supportive of his academic endeavors and hope that he will become the first to attend college in his family. Both of his two older siblings dropped out of high school in 9th grade. Nick is an average student in school and struggles somewhat in math and writing. I have no doubt that he can graduate high school and even college if he really wants to. Nick loves pets and animals. I also noticed that he seems especially interested in the topic of climate change in class.***

-7th grade instructor

--

PROMPT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. You will not be able to go back to this screen. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

Below is information about your assigned pen pal.

Name: Priscilla
Age: 13
Grade: 8th
School: Desert Wind Middle School, Maricopa Unified School District #20

Reason for referral: ***I think that this program might be helpful for Priscilla, one of my 8th grade students. Priscilla is one of the most ambitious 8th grade students I know. She has had her mind set on becoming a veterinarian since starting middle school and volunteered at an animal shelter over the summer. Priscilla works very hard in school and does ok. However, she seems to be getting frustrated with herself for not achieving the stellar grades that she would like. Unfortunately, Priscilla does not get a lot of support from her immediate family when it comes to school and homework. I also do not have as much time as I would like to give Priscilla individualized attention.***

– 8th grade teacher

PROMPT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. You will not be able to go back to this screen. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

Below is information about your assigned pen pal.

Name: Bobby
Age: 13
Grade: 8th
School: Desert Wind Middle School, Maricopa Unified School District #20

Reason for referral: ***I think that this program might be helpful for Bobby, one of my 8th grade students. Bobby is one of the most ambitious 8th grade students I know. He has had his mind set on becoming a veterinarian since starting middle school and volunteered at an animal shelter over the summer. Bobby works very hard in school and does ok. However, he seems to be getting frustrated with himself for not achieving the stellar grades that he would like. Unfortunately, Bobby does not get a lot of support from his immediate family when it comes to school and homework. I also do not have as much time as I would like to give Bobby individualized attention.***

-8th grade teacher

PROMPT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. You will not be able to go back to this screen. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

Below is information about your assigned pen pal.

Name: Erin
Age: 13
Grade: 8th
School: Desert Wind Middle School, Maricopa Unified School District #20

Reason for referral: *I decided to refer one of my previous students, Erin, to this program in hopes that it will provide her with some extra encouragement during the transition period between middle school and high school. Erin's parents are incredibly supportive of her academic endeavors and hope that she will become the first to attend college in her family. Both of Erin's two older siblings dropped out of high school in 9th grade. Erin is an average student in school but struggles somewhat in math and writing. I have no doubt that she can graduate high school and even college if she really wants to. Erin loves pets and animals. I also noticed that she seems especially interested in the topic of climate change in her class.*

-7th grade instructor

PROMT: Use the information you learned in this training to write letter of approximately three paragraphs in length to your assigned student encouraging him or her to overcome the particular academic obstacle he or she is facing. Include somewhere in the letter a time in your own life in which you overcame a similar obstacle. It is up to you exactly how you would like to compose the letter, but keep in mind that profanity, discouraging comments, and any other type of inappropriate content will not be sent.

DO NOT CONTINUE UNTIL YOU ARE READY TO SUBMIT THE LETTER. You may want to create your letter in a word processor before continuing. If you decide to click "Save & Exit" be sure to first note the information about your assigned pen pal. You will not be able to go back to this screen. Log back in or press "Continue" once the letter is composed and you are ready to submit it.

APPENDIX O

AUTOMATED EMAIL VERIFICATION OF COMPLETION

SUBJECT: PEN PAL LETTER- VERIFICATION OF COMPLETION

Thank you for participating in the Pen Pal Letter study! This email will serve as your verification of your completion of the pen pal letter assignment for UNI 150. Please submit this email to your UNI 150 instructor for credit on the assignment.

Natalie Fabert, M.Ed.
Doctoral Candidate
School of Letters and Sciences
nfabert@asu.edu

APPENDIX P

EXAMPLE UNI 150 COURSE SYLLABUS

COURSE SYLLABUS
UNI 150 – Choosing a Major

Fall 2012

Instructor Information:
Name: Office Hours:
E-mail:
Course Information: Section: Meeting Time/Location:

Course Objectives: During this course, students will:
Complete advanced assessments and clarify interests, values, and personality as related to choice of major/career,
Learn and use new resources to explore the major(s) and career(s) they are considering,
Define roadblocks and develop solutions in regard to choosing a major/career path,
Learn the value of and opportunities related to internships,
Write an up-to-date resume, and
Identify a major and connect with the appropriate department.

Required Text and Materials:

1. Career Guide online at http://students.asu.edu/files/Career%20Guide%20low%20res.pdf
2. An ASU e-mail account
3. My ASU Blackboard account for this class

Course Structure: The course employs in-class activities, collaborative learning, and online activities. To enable the students and the instructor to have frequent and meaningful interaction with each other and with the group, class size is limited to 19 students per section. UNI 150 is a 1-credit course that can count toward graduation in the form of an elective. UNI 150 is not an "easy A" course, nor is it remedial. You will receive a letter grade for UNI 250, but no +/-.

Student Responsibilities:

1. **Attend class**. Notify the instructor before class meets if you will be arriving late or leaving early, either of which may result in a deduction in your final grade. Make certain to obtain any missed information and assignments from Blackboard or another student.
2. **Participate throughout every class meeting**. This is not a typical "lecture" class. Discussion is not only encouraged, but necessary to facilitate a fulfilling classroom experience.

3. **Turn in all out of class assignments at the beginning of class**. Assignments not submitted *at the beginning of class* are considered late. Late assignments will be accepted no later than one class period after the initial class period in which they were due and will receive half credit.
4. **Complete all in-class exercises in full and to the best of your ability.** In-class activities (which translate into participation points) will be graded on both effort and product.
5. **Check Blackboard before each class period.** You will be responsible for checking blackboard the night before each class for announcements regarding changes in assignments, readings, etc. Additionally, as a student, it is your responsibility to track your grade on blackboard and contact the instructor by the second class period after an assignment grade has been posted, if there is an inconsistency.
6. **Turn off all electronic devices.** This includes, but is not limited to, cell phones, laptop computers, and iPods. If it plugs in or needs a battery, turn it off. If you are using any such device during class, you will be asked to leave for the remainder of the class, and will be marked absent for the day.

<u>Written Work</u> All written work must fulfill the following criteria. It must be:

- 12 point font
- Double-spaced
- Word count posted
- Typed
- All pages must be stapled together.

Incorrect fonts, spacing, and no posted word count are subject to point deductions. <u>Written work will not be accepted if it is not typed or not stapled</u>. To fulfill the word count posting requirement, the number of words in the assignment must be typed, under your name. For an assignment to be counted as on-time, a paper copy must be submitted at the beginning of class, on the date it is due. An emailed copy of the assignment will not be accepted, unless this form of submission is explicitly requested in the assignment description on blackboard.

<u>Attendance</u>: Studies show a direct relationship between classroom attendance and learning outcomes. Because much of the learning in ASU 101 takes place via classroom activities and group interaction, attendance is taken daily and is an integral part of the ASU 101 grade. Because our class has few in-person meetings, a strict attendance policy is enforced. Attendance equates to <u>showing up on time, listening, turning in assignments and participating in class discussions appropriately</u>. Students who miss the taking of attendance at the beginning of class will be marked absent. Students who arrive within 15 minutes of class beginning, (as determined by the instructor) will be marked late.
Arriving late to class TWICE = one absence.

Each absence will result in a 10 point deduction from your final grade. Three absences in the course will result in an E (failing the course).

Date	Topic-	Reading Due (Career Guide)	Assignment DUE on this date
Day 1	Intro, Motivation, Goals: Syllabus & Expectations, Campus Resources & Tour, Planner		Review the syllabus and blackboard
Day 2	Kuder Assessment & Major Research, Situational Identity Matrix Meet with Professor Planner/syllabi completed	8-10	Kuder Assessment Printed Campus Tour and Resources You Will Use Bring syllabi for all classes Bring computer if possible
Day 3	Visit Career Services Informational Interviews	24-29	Kuder & Major Paper Pen Pal Letter
Day 4	Values & Life Design	11-14, 19	Discussion Board- Info Interview Contact Info Career Research
Day 5	Diversity in the Workplace Situational Identity Matrix	15-17	Planner/syllabi Compliance
Day 6	Decision Making & Goal Setting		Informational Interview Diversity Reflection Presentations
Day 7	Presentations Continued		Presentations

See ACD 304–04 for "Accommodation for Religious Practices" regarding absences and ACD 304–02, for "Missed Classes Due to University-Sanctioned Activities."

Class Participation: You can earn 1 point for your class participation each day. Engaging in thoughtful discussion, listening intently while others speak, and participating in class activities counts toward participation. Arriving late or leaving early from class, or conversation during class that is not on-topic, will result in deductions from your participation points. Participation points are also gained by attending one mandatory individual meeting with your instructor.

Additionally, everyone in class deserves respect and consideration. Diverse opinions, values and beliefs will be respected. Please refrain from using profanity and language that may be offensive to, or that denigrates, another person or group. I may eject, penalize or drop a disruptive student from the course. Any violation of class, School, College or University rules constitutes disruption of the academic process.

Finally, come prepared for discussions by reading any assignments before class. It is my hope that you will give this class and all if its activities a personal sense of purpose and discover different ways you can make various strategies work for you. Your grade, but most importantly, how much you take away from this class, is fully dependent upon the level and quality of your participation. Data collected in this class may be used for research purposes.

Class Calendar: (All assignment descriptions are available on blackboard)

Course Grading

Assignments	**Total**	**Earned**
#1 Planner/Syllabi	10	
#2 Kuder & Major Paper	15	
#3 Campus Tour and Resources You Will Use	10	
#4 Pen Pal Letter	5	
#5 Informational Interview (includes identify interviewee in week 3)	15	
#6 Career Research	15	
#7 Diversity Reflection	10	
#8 Final Presentation	10	
Meet with professor	2	
Participation	8	
Total	**100**	

Attendance*	10 points lost for every class missed, 2 LATE arrivals to class = 1 absence

This course is graded using a regular letter scale from A through E. The grading scale is:

A	90-100 points	C	70-79 points		
B	80-89 points	D	60-69 points	E	less than 60 points

<u>Electronic Mail (Gmail):</u> Instructors and ASU staff will use email regularly to correspond with students. Make sure to check your emails frequently. Any announcements regarding this class will be posted in the 'ANNOUNCEMENTS' in the BlackBoard.

Academic Accommodations: If you need academic accommodations or special consideration of any kind to get the most out of this class, please let me know at the beginning of the course. If you have a disability and need a reasonable accommodation, please contact Disability Resources for Students. http://www.asu.edu/studentaffairs/ed/drc/

Academic Integrity: University College strongly believes in academic integrity; thus, instructors in the College do not tolerate cheating and plagiarism. Instructors who find compelling evidence of academic dishonesty will actively pursue one or more of the following actions: assigning a grade of XE ("failure through academic dishonesty") to the student, advocating the suspension or expulsion of the student, and/or referring the student to Student Judicial Affairs. If a student who is charged with academic dishonesty is found to be in violation, then one or more of these disciplinary actions will be taken. For further information, please read the Student Academic Integrity policy and the code of conduct at:
http://provost.asu.edu/academicintegrity.

Code of Conduct: Students are required to adhere to the behavior standards by the Arizona Board of Regents http://students.asu.edu/files/StudentCodeofConduct.pdf . Violent or threatening conduct is not tolerated, see SSM 104–02, "Handling Disruptive, Threatening, or Violent Individuals on Campus"

Course Revisions: The instructor reserves the right to amend this syllabus as needed, with notice to students in class.

APPENDIX Q

INSTRUCTIONS GIVEN TO GRADUATE TEACHING ASSISTANTS

Pen Pal Letter Assignment: Instructions for University College TAs

Brief overview: The "Pen Pal Letter" is a mandatory UNI 150 assignment worth 5% of the final grades. For this assignment, students will complete an online training and surveys as part of a dissertation research project. Instructors will give students 15 minutes to work on Part 1 of the assignment on their computers during the second UNI 150 class period. Students are to be directed to the following link:

https://UNI150PenPalLetterPart1.questionpro.com.

In the survey they complete for Part 1, students will be asked to create a unique ID number (log in code) and give an email address. Students will be emailed a link to Part 2 of the assignment to this email address within approximately 24 hours. They are to complete Part 2 of the assignment by next class. They will need the log in code they created in Part 1 to complete Part 2. Students who email a certificate of completion to their instructor by the beginning of the third class should receive full credit for the assignment.

UNI 150, Day 1:

Remind your students on day one to bring their computers next class if possible. These instructions are also in the course syllabus. Also remind students to bring their ID card. They will use their ASU student ID numbers to create their unique log in code.

UNI 150, Day 2:

Protect the last 15 minutes of Day 2 for the Pen Pal Letter assignment. The italicized words below are for you to read aloud to your students during this last portion of class:

> "*In addition to the Kuder & Major Paper, the Pen Pal Letter assignment is due next week. This assignment is your first opportunity to participate in one of the many different scholarly research projects currently underway at ASU. You will complete the first part of the assignment now. Go ahead and take out your computers, for those who have them, and type in the following link:* https://UNI150PenPalLetterPart1.questionpro.com *This link will direct you to additional information and instruction. You will receive a link to the second part of the assignment via email approximately 24 hours after you complete Part 1. Plan to spend up to one and a half hours on the second part of this assignment. When you are finished, you will receive an electronic certificate of completion. You must email this certificate of completion to me by the start of the next class period to receive full credit on the assignment."*

Students who do not have their computers can use classroom computers or complete Part 1 at home. Make sure they write down the link above and remind them to complete this part of the assignment as soon as possible, since it will take approximately one day for them to have access to the rest of the assignment.

For your information, students will be shown the following to IRB-approved information letter:

INFORMATION LETTER

Hello! My name is Natalie, and I am a doctoral student under the direction of Professor Bernstein in the School of Letters and Sciences. First of all, welcome to your first week as an official ASU sun devil! Also, congratulations on your decision to begin this journey with the University College. The courses available to you through the UC Major and Career Exploration program will help you learn how to best position yourself for success at ASU and beyond.
As you may already know, Arizona State University is a research institution. Research is the process of learning something new about the world by gathering and analyzing of information using a systematic series of steps. Instructors and students are not only at ASU to teach and learn but to create *new* knowledge through scholarly research. Below are examples of research topics that are currently being examined by ASU researchers:

- How to create renewable energy sources
- How to apply social psychological principles to reduce religious conflict
- How to ensure long-term access to clean water supplies for Phoenix area residents
- How to invent technology that can better detect chronic diseases
- How to plan for sustainable urban development
- How to enhance physical therapy with virtual reality software

As you can see, ASU researchers study a wide variety of topics. However, as a scholarly community, we pride ourselves on conducting research that meets practical and social needs of local and global communities.

For assignment # 4 titled "Pen Pal Letter" you will be asked to participate in my dissertation research project, designed to explore the impact of a training delivered over the Internet. This opportunity will be the first of many you will have during your time at Arizona State University to contribute to research as a participant or as the author of your own study.

You will be asked to complete a series of questions. As stated in the UNI 150 syllabus, data collected in this class may be used for research purposes, including the information you submit for as part of this study. Your instructor will not have access to the answers you submit in this study but will be notified once it is complete.

For students who give their permission, data collected in this study will be link to their overall GPA at the end of the Fall 2012 semester. This information will be kept in a password protected, encrypted location. Mary Dawes, the director of the UC academic and career exploration program, will use students' login information to link grades to the submitted data. She will then be transforming the data into a list that does not contain any identifying information. Granting permission to access your GPA for the purposes of this research study is voluntary and will not

affect the credit you will receive for completing this assignment.   You can withdraw your consent at any time without penalty.
If you would like to grant permission for the researcher of the study to access your end-of-the-semester grade point average, please check the box below.

☐ ____

If you have any questions concerning the research study, please contact me at Natalie.Fabert@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

Thank you,

Natalie Fabert, M.Ed.
Doctoral Candidate
School of Letters and Sciences
Arizona State University

Also for your information, and in case students have questions, students will be given the following instructions to create their ID numbers. It is important that they follow these specific instructions.

> In approximately 24 hours after you finish Part 1 of the Pen Pal Letter Assignment in class, you will be sent a link to Part 2 of the Pen Pal Letter Assignment. ***You will need to create a unique log in code using the instructions below in order to access this link that you will be sent***.
>
> Please generate a code based on the month of your birthday, the first letter of your middle name (use your first name if you don't have a middle name), and the last 2 digits of your student ID. ***Your code must be in this format in order for you to complete the assignment.***
>
> Please go through the following two examples, and then provide your code.
>
> Example 1: Born in August, middle name is Brian, student ID is XXXX-□XX-□XX06. The code is 08B06.
>
> Example 2: Born in November, middle name is Ann, student ID is XXXX-□XX--□XX14. The code is 11A14.

UNI 150, Day 3 +
Give full credit to students who email you a copy of their certificate of completion of the Pen Pal Letter assignment. Standard late policies apply. For validity purposes, please discourage students from talking about the study. Explain that they will receive additional information about the

study at a later date and to address any burning questions to Natalie.Fabert@asu.edu or Mary Dawes medawes@asu.edu.

HUGE thanks to instructors for your help with this project! Instructors can contact me directly as needed at XXX-XX-XXXX.

APPENDIX R

DEBRIEFING STATEMENT

SUBJECT: PEN PAL STUDY: E-GIFTS & FINAL DEBRIEFING STATEMENT - PLEASE READ

Dear Pen Pal study participants,

If you completed the Pen Pal Study follow-up survey, you should have already received either your Starbucks or Amazon $5 gift certificate via email. Please check your spam mailbox if you have not received this e-gift.

Whether or not you completed the follow-up survey, please read the following debriefing statement regarding the Pen Pal study that you completed as part of your UNI 150 coursework at the beginning of the fall semester:

PEN PAL STUDY: DEBRIEFING STATEMENT

In this study, you may have been asked to create an Internet Blog reflecting on times you overcame academic obstacles. If so, you were told that this blog would be sent to a middle school student as part of an online mentoring program for at-risk youth. However, this was not true; the online mentoring program referred to in the study does not exist, and the Internet blog you created was not sent to a child. Instead, the true purpose of the study is to examine different factors that determine how college students like you make academic and career decisions, which is why you were asked a series of questions about your goals.

Previous research suggests that an effective way to enhance motivation for learning is to provide education to students about the biological basis of learning, and to emphasize the fact that intelligence is not entirely fixed and innate but can improve with education, experience, and effort. I am interested in understanding the specific effects of this type of training on students' motivation to pursue science and engineering. Therefore, you may have received education about the biological basis of learning before answering the series of questions about your career goals. The reason you may have been asked to create an Internet blog and told that it would be read by a child is because research suggests that individuals learn a concept best when they teach the concept to others. Research also suggests that people are more likely to be persuaded of a particular viewpoint when they are called to advocate for that particular viewpoint.

Some of you received training on persuasive writing skills or no training at all in order to compare the results of the study. Please note that the content included in all of the trainings was not fabricated and was based on rigorous research findings.

If you have any additional questions about this study, please contact the researcher at nfabert@asu.edu. You can also contact my advisor, Bianca Bernstein, at bbernstein@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

Thank you again for your contribution to this scholarly research!

Natalie Fabert, M.Ed.

APPENDIX S

EMAIL WITH HYPERLINK TO PART 2

SUBJECT: UNI 150 PEN PAL LETTER: PART 2

Hello,

This email contains your particular link to the second part of the pen pal letter assignment/study. You will need to complete the entire survey/assignment to receive credit. Once you successfully complete the assignment/study, you will be sent an email containing a verification of your completion.

Log in with the ID code you created in Part 1. As a reminder, the ID code you created was based on the month of your birthday, the first letter of your middle name (use your first name if you don't have a middle name), and the last 2 digits of your student ID. (For example: Born in August, middle name is Brian, student ID is XXXX-XX□XX06. The code is 08B06).

Click on this link below to access the assignment/study:
start study

If you have any questions or problems with this assignment, please contact Natalie at nfabert@asu.edu.

Thank you!

Natalie Fabert, M.Ed.
Doctoral Candidate
School of Letters and Sciences
Arizona State University
nfabert@asu.edu

APPENDIX T

REMINDER EMAIL TO PARTICIPANTS

SUBJECT: REMINDER- PLEASE COMPLETE PART 2 OF THE PEN PAL LETTER ASSIGNMENT

Hello,

This is a reminder to complete Part 2 of the pen pal letter assignment for UNI 150 if you have not done so yet. Once you successfully complete Part 2, you will receive an emailed confirmation of your completion. You need to submit this email to your instructor by your next UNI 150 class period to receive full credit on this assignment. If you started Part 2 but did not finish yet, use the link emailed to you earlier to continue where you left off. Otherwise, start from the beginning by using the following link:

Start Survey

Please let me know if you have any issues with this study/assignment (e.g. logging in, accessing your particular link to part 2, saving your work, or receiving an email confirmation). I am happy to help.

Natalie Fabert, M.Ed.
Doctoral Candidate
School of Letters and Sciences
Arizona State University

APPENDIX U

TABLES PRESENTING MAXIMUM LIKELIHOOD ESTIMATES OF A SERIES OF PATH MODELS

Table U1.
Maximum Likelihood Estimates of Hypothesized Path Model

Parameter	Unstandardized	*SE*	Standardized
Factor Loadings			
IQ Att ↔ Disbelief	.508	.063	.363
IQ Att → Course SE	.186[b]	.094	.099
IQ Att → Career SE	.135[a]	.099	.070
Disbelief → Course SE	.127[a]	.084	.074
Disbelief → Career SE	.027[a]	.090	.015
Course SE ↔ Career SE	3.460	.231	.754
Course SE → Intent	.163	.044	.214
Career SE → Intent	.299	.046	.400
Factor variances			
IQ Att	1.286	.067	---
Disbelief	1.528	.070	---
Residual variances			
Course SE	4.470	.240	.980
Career SE	4.715	.257	.994
Intent	1.764	.101	.665

Note. IQ Att. = IQ Attitude; Disbelief = Stereotype Disbelief; Course SE = STEM Course Self-Efficacy; Career SE = STEM Career Self-Efficacy; Intent = STEM Intentions. $^{a}p > .05$; $^{b}p < .05$; for all other unstandardized estimates, $p \leq .001$. Double headed arrows indicate two-way paths.

Table U2.
Maximum Likelihood Estimates of Hypothesized Path Model Estimated for Female Participants

Parameter	Unstandardized	*SE*	Standardized
	Women		
Factor Loadings			
IQ Att ↔ Disbelief	.511	.074	.387
IQ Att → Course SE	.063[a]	.125	.033
IQ Att → Career SE	-.041[a]	.128	-.022
Disbelief → Course SE	.348	.101	.200
Disbelief → Career SE	.232[b]	.108	.137
Course SE ↔ Career SE	3.002	.276	.719
Course SE → Intent	.176[c]	.056	.229
Career SE → Intent	.291	.060	.369
Factor variances			
IQ Att	1.197	.087	---
Disbelief	1.460	.084	---
Residual variances			
Course SE	4.218	.289	.954
Career SE	4.135	.296	.983
Intent	1.798	.139	.689

Note. IQ Att. = IQ Attitude; Disbelief = Stereotype Disbelief; Course SE = STEM Course Self-Efficacy; Career SE = STEM Career Self-Efficacy; Intent = STEM Intentions. [a]p >.05; [b]p <.05; [c]p <.01; for all other estimates, $p \leq .001$. Double headed arrows indicate two-way paths.

Table U3.
Maximum Likelihood Estimates of Hypothesized Path Model Estimated for Male Participants

Parameter	Unstandardized	*SE*	Standardized
	Men		
Factor Loadings			
IQ Att ↔ Disbelief	.453	.112	.308
IQ Att → Course SE	.381[c]	.122	.223
IQ Att → Career SE	.403[c]	.139	.221
Disbelief → Course SE	-.012[a]	.121	-.008
Disbelief → Career SE	-.063[a]	.131	-.036
Course SE ↔ Career SE	3.108	.363	.749
Course SE → Intent	.102[a]	.072	.142
Career SE → Intent	.270	.072	.401
Factor variances			
IQ Att	.403	.105	---
Disbelief	1.543	.117	---
Residual variances			
Course SE	3.868	.388	.951
Career SE	4.448	.420	.955
Intent	1.552	.143	.733

Note. IQ Att. = IQ Attitude; Disbelief = Stereotype Disbelief; Course SE = STEM Course Self-Efficacy; Career SE = STEM Career Self-Efficacy; Intent = STEM Intentions. [a]p >.05; [b]p <.05; [c]p <.01; for all other estimates, $p \leq .001$. Double headed arrows indicate two-way paths.

Table U4.

Maximum Likelihood Estimates of "Constrained" Path Model

	Women			Men		
Parameter	Unst.	SE	St.	Unst.	SE	St.
Factor Loadings						
IQ Att ↔ Disbelief	.491	.062	.375	.491	.062	.330
IQ Att → Course SE	.209[b]	.088	.108	.209[b]	.088	.124
IQ Att → Career SE	.157[a]	.095	.082	.157[a]	.095	.060
Disbelief → Course SE	.184[b]	.079	.105	.184[b]	.079	.115
Disbelief → Career SE	.102[a]	.084	.059	.102[a]	.084	.060
Course SE ↔ Career SE	3.094	.223	.725	3.094	.223	.746
Course SE → Intent	.152	.045	.202	.152	.045	.202
Career SE → Intent	.275	.047	.360	.275	.047	.387
Factor variances						
IQ Att	1.185	.100	--	1.185	.100	--
Disbelief	1.445	.083	--	1.445	.083	--
Residual variances						
Course SE	4.303	.265	.969	4.303	.265	.962
Career SE	4.228	.271	.986	4.228	.271	.985
Intent	1.809	.136	.724	1.809	.136	.691

Note. Unst.= Unstandardized; St. = Standardized. IQ Att. = IQ Attitude; Disbelief = Stereotype Disbelief; Course SE = STEM Course Self-Efficacy; Career SE = STEM Career Self-Efficacy; Intent = STEM Intentions [a]$p > .05$; [b]$p < .05$; for all other unstandardized estimates, $p \leq .001$. Double headed arrows indicate two-way paths.

Table U5.
Maximum Likelihood Estimates of "Unconstrained" Path Model

	Women			Men		
Parameter	Unst.	*SE*	St.	Unst.	*SE*	St.
Factor Loadings						
IQ Att ↔ Disbelief	.491	.062	.375	.491	.062	.330
IQ Att → Course SE	.063[a]	.125	.032	.381[c]	.122	.226
IQ Att → Career SE	-.039[a]	.127	-.021	.403[c]	.139	.224
Disbelief → Course SE	.348	.101	.198	-.012[a]	.121	-.008
Disbelief → Career SE	.232[b]	.108	.136	-.064[a]	.131	-.037
Course SE ↔ Career SE	3.040	.219	.722	3.040	.219	.744
Course SE → Intent	.150	.044	.201	.150	.044	.200
Career SE → Intent	.276	.046	.360	.276	.046	.392
Factor variances						
IQ Att	1.185	.084	--	1.418	.100	--
Disbelief	1.445	.083	--	1.568	.124	--
Residual variances						
Course SE	4.252	.263	.955	3.821	.286	.950
Career SE	4.172	.265	.983	4.371	.333	.954
Intent	1.806	.136	.724	1.563	.148	.687

Note. Unst.= Unstandardized; St. = Standardized. IQ Att. = IQ Attitude; Disbelief = Stereotype Disbelief; Course SE = STEM Course Self-Efficacy; Career SE = STEM Career Self-Efficacy; Intent = STEM Intentions [a]$p > .05$; [b]$p < .05$; [c]$p < .01$ for all other unstandardized estimates, $p \leq .001$. Double headed arrows indicate two-way paths.

Table U6.

Maximum Likelihood Estimates of the Gender Specific (Final) Model

Parameter	Women Unst.	Women *SE*	Women St.	Men Unst.	Men *SE*	Men St.
Factor Loadings						
IQ Att ↔ Disbelief	.491	.062	.375	.491	.062	.330
IQ Att → Course SE	---	---	---	.377	.119	.224
IQ Att → Career SE	---	---	---	.380[c]	.140	.212
Disbelief → Course SE	.370	.091	.211	---	---	---
Disbelief → Career SE	.219[b]	.099	.128	---	---	---
Course SE ↔ Career SE	3.043	.219	.722	3.043	.219	.744
Course SE → Intent	.151	.044	.202	.151	.044	.201
Career SE → Intent	.275	.046	.359	.275	.046	.391
Factor variances						
IQ Att	1.185	.084	---	1.418	.100	---
Disbelief	1.445	.083	---	1.568	.124	---
Residual variances						
Course SE	4.257	.262	.956	3.819	.285	.950
Career SE	4.177	.266	.984	4.380	.334	.955
Intent	1.809	.136	.725	1.563	.148	.688

Note. Unst.= Unstandardized; St. = Standardized. IQ Att. = IQ Attitude; Disbelief = Stereotype Disbelief; Course SE = STEM Course Self-Efficacy; Career SE = STEM Career Self-Efficacy; Intent = STEM Intentions [a]$p > .05$; [b]$p < .05$; [c]$p < .01$ for all other unstandardized estimates, $p \leq .001$. Double headed arrows indicate two-way paths.