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Abstract

The relatively small number of female students who pursue a science, technology, engineering, and mathematics (STEM) career is a significant educational and social problem. This dissertation addresses aspects of the STEM education pipeline problem through a quantitative study of the career aspirations of students in a high performing STEM-based career academy vocational high school. This study examines students' career aspirations in the context of a three-year change initiative that substantially addresses the absence of curricula pertaining to the high school's intended engineering-focused vocational program. This study draws upon social cognitive career theory (SCCT) as a theoretical framework, and calculates descriptive statistics and multifactorial analysis of covariance to analyze factors such as outcome expectations, self-efficacy, background contextual supports, and personal inputs to predict gender differences in aspirations for a career in engineering.

The results of this quantitative research study were summarily categorized according to two primary research questions, which produced several key findings. First, the main effect of interests explained significant amounts of variance in goals, while grade-level and background contextual affordances explained significant amounts of variance in interests. The main effect of gender, when including grade-level and interests, explained significant amounts of variance in goals. However, this effect disappeared when outcome expectations and background contextual affordances were added to the model. Similarly, neither the main effect of semester nor any two-way interactions involving semester explained significant amounts of variance in either interests or goals.

Rather than advancing the numerous studies that explore the decisions made and persistence towards STEM careers during and after postsecondary levels, this study addresses the

gap in the extant literature by virtue of its focus on the high school context. It is the hope that these findings inform the research on this issue generally and provide information that can support other high schools with similar STEM programs to develop ways to reduce the gender gap in mathematics-intensive STEM fields like engineering.

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At the onset of this journey, I recall attending an open house where a number of soon-to-be graduates offered our cohort advice about how to manage the multidimensional demands of a doctoral study. These soon-to-be graduates warned us that our journey would demand sacrifice, dedication, and an unrelenting commitment to pushing through in the face of failure. They warned us that the program would place stress on our careers, family, and friendships. Their best advice was to establish designated writing locations, to make some progress each week, and to carve out quality time for family and friends. They also encouraged us to develop close ties with our cohort, claiming this would serve as a major source of support throughout our journey. In each case, their advice could not have been more on point.

This journey was a significant challenge, but I feel rewarded by the struggle and appreciative of Rutgers University for pushing me beyond the point at which I thought I would falter. However, getting to this point would simply not have been possible without several people pushing me forward in either gentle or not-so-subtle ways. First, I would like to thank my wife, Michelle, for the unwavering support and repeatedly selfless behavior throughout the past four years. It would be impossible to recall the number of missed dinners together as family, outings with our daughter Samantha - who was born two months before this journey began! – visits to see relatives during the holidays, or any other daily occurrence that a parent gets to enjoy with their family. As a mother, I witnessed Michelle accept near full responsibility for taking care of Samantha, and as a teacher I watched her spend countless nights grading papers and writing lesson plans, all while I hid in a room punching keys on a laptop. There are not enough words in the English language to adequately describe my appreciation and gratitude for what my wife did for me throughout this process. All I can say is: thank you and I love you.

Secondly, I would like to thank our cohort for making this journey bearable. There were many weekends where we would talk one another back from quitting. These members were confidants, counselors, friends, study partners, editors, and a host of other wonderfully necessary contributors, and I would not have gotten here without them.

Thirdly, I would like to thank the Union County Vocational-Technical School District, specifically Union County Magnet High School, for allowing me to utilize our school community to conduct this study. The beginning of my tenure as principal was, at best, a blur! My daughter was born in July 2015, I started as principal in August 2015, and because that was not enough, I began this journey in September 2015. Despite the craziness, I knew early on that I wanted to explore a study involving girls in STEM. As the father to a little girl, who continues to wish for nothing more than for her to have limitless opportunities, and as the principal of a STEM high school, this study seemed like a perfect fit from the onset. The students at Magnet are some of the brightest students in the country, but it is their humility, sincerity, and overall good-naturedness that defines them as a special group of students. Combined with the most talented educators and administrators in the profession, and a passionately supportive parent community, it is a blessing each and every day to walk into our school.

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DEDICATION

I dedicate this to my wife Michelle, my daughter Samantha, my family and friends, and all those who wish to pursue their dreams.

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Chapter 1: Introduction

The relatively small number of female students who pursue science, technology, engineering, and mathematics (STEM) careers is a significant educational and social problem. This dissertation addresses aspects of the STEM education pipeline problem through a quantitative study of the career aspirations of students in a high performing STEM-based career academy vocational high school. In particular, this study examines data regarding students' career aspirations in the context of a three-year change initiative that substantially addressed the absence of curricula pertaining to the high school's intended engineering-focused vocational program. This study draws upon social cognitive career theory (SCCT) as a theoretical framework and utilizes the engineering subsection of a STEM Career Interest Survey (STEM-CIS) developed by Kier, Blanchard, Osborne, and Albert (2014). Rather than advancing the numerous studies that explore the decisions made and persistence towards STEM careers during and after postsecondary levels, this study addresses the gap in the extant literature by virtue of its focus on the high school context (Chen, 2009; Sadler, Sonnert, Hazari, & Tai, 2012). This chapter explains the significance of this study and local context, introduces the theoretical framework, sets out the problem statement and research questions, provides an overview of the methodology, identifies important limitations of this study, and defines key terms.

1.1. Significance of the Study and Local Context

As the principal of Union County Magnet High School (UCMHS), a high performing STEM-based career academy vocational high school that makes up one of five high schools within the Union County Vocational-Technical School District (UCVTS), I had the opportunity to speak with students regarding their reasons for attending the school and to gain insight into the types of careers they intend to pursue upon graduation. In fall 2015, as a first year principal, it was made clear by school and district personnel, as well as by members of the parent community, that students were attending UCMHS primarily for academic and social reasons and not for the vocational program provided by the school. Student data was collected using informal meetings with members of the school's class council and student government, which allowed for interviews of a cross-section of the school's student body. Data from these interviews confirmed earlier reports. Students revealed that they were attending for a variety of academic and social reasons, none of which included a specific interest in pursuing an engineering career. Additionally, students reported that UCMHS did not have a clear vocational purpose but was appealing for its recognition as a high achieving, nationally ranked high school. In many cases, students reported that UCMHS provided a better alternative to their home school because it was socially accepting and a place where it was "safe and cool to be nerdy" (personal communication, September, 2015).

As a vocational high school, there is a responsibility to distinguish the curricular program from traditional comprehensive high schools, particularly since each sending district pays the tuition for the students to attend the school district. In light of the student interview data, specifically the data that confirmed UCMHS was perceived by students to be devoid of a clear vocational purpose, a multi-year curricular change process designed to reshape UCMHS's vocational purpose was enacted. The primary objective was to reframe the message being sent to the student and parent community by providing courses that would illustrate the commitment to being engineering focused, while also remaining cognizant of the academic and social characteristics favored by the students. The desired change included attracting students interested in engineering as a career. This goal involved a number of key stakeholders, included the development and implementation of six new engineering electives, required the successful completion of Advanced Placement Calculus for all students, and formed the foundation for a stronger vocational message during the fall information sessions used to recruit students to apply to UCMHS.

The students in the class of 2018 and the class of 2019 were pitched a very different program when they attended the mandatory information sessions in the fall of their respective eighth-grade years in anticipation of joining the Union County Vocational-Technical School District (UCVTS). The vocational message that constituted the change initiative as an engineering school was only incorporated in the fall 2015. As a result, the upperclassmen (class of 2018 and class of 2019) participating in the survey encountered a different educational experience than the underclassmen (class of 2020 and beyond) at the point of admission and during their time at UCMHS, which might explain the lower participation rates amongst the upperclassmen.

Three years into the change process, early data showed a shift in enrollment between male and female students. In June 2018, there were 304 students enrolled in UCMHS, of whom 172 were male (56.6%) and 132 were female (43.4%). Student enrollment data by grade-level enrollment consisted of 70, 77, 80, and 77 for the class of 2018 through the class of 2021, with female student enrollment for these years consisting of 29 (41.4%), 33 (42.9%), 43 (53.8%), and 27 (35.1%), respectively. The incoming class of 2022 was projected to include 29 (37.7%) female students, which was more in line both with the class of 2021 female student enrollment record as well as with national statistics that indicate engineering is a male-dominated field. As evidenced by these data, and since the curricular changes were adopted three years ago, UCMHS has experienced a noticeable decline in the number of female students admitted into the school, particularly for the classes of 2021 and 2022, which are the two classes that entered UCMHS after the curricular changes were implemented.

The experience of UCMHS is consistent with the larger pattern in American education of a large gender gap in both starting and persisting in mathematics-intensive STEM fields like engineering. In 1995, female students earned 17.3% of the bachelor degrees in engineering in the United States. Yet, female students earned 49.8% of the bachelor degrees in both the biological sciences and social sciences. In 2014, nearly twenty years later, females earned 19.8% of the bachelor degrees in engineering, 58.0% of the bachelor degrees in biological sciences, and 54.6% of the bachelor degrees in social sciences. Even this modest percentage of female students earning a bachelor degree in engineering could represent an improvement over the past, but in 2015 only 14.5% of engineers were female. Another way of viewing this educational problem is that only 1.7% of females earning a bachelor degree did so in engineering compared to 9.3% of males (National Science Foundation, 2015). These data indicate that, despite multiple efforts to encourage females to pursue mathematics-intensive STEM fields, the vast majority is either not pursuing or not persisting in the engineering profession STEM education pipeline.

Several reasons are cited in the research literature for why disproportionately fewer female students pursue or persist in the engineering profession STEM pipeline. These reasons include institutional and social barriers faced by females throughout K-12 education, higher education, and career arenas (Bottia, Stearns, Mickelson, Moller, & Valentino, 2015). Defined as “events or conditions, either within the person or in his or her environment, that make career progress difficult” (Swanson & Woitke, 1997, p. 434), barriers have long been considered both intrapersonal and environmental in nature. An extraordinarily broad range of factors have been suggested as barriers contributing to the low rates of female student participation in mathematics-intensive STEM fields: lack of sufficient academic preparation in mathematics and science, poor attitudes about mathematics and science, fewer positive experiences in mathematics and science domains, absence of female role models, biased curricula and pedagogy, the existence of a chilly climate where females feel unwelcomed, pressure to conform to societal and cultural norms, and perhaps even biological differences between males and females (Blickenstaff, 2005). The combined effects of these factors contribute to a phenomenon known as the "leaky STEM pipeline," which has been used to characterize the disproportionately low number of females entering and persisting in pathways to STEM careers in physics, chemistry, engineering, and computer science (Falk, Rottinghaus, Casanova, Borgen, & Betz, 2016). Research has shown that the presence of even a few of the social and institutional barriers among those possible factors can result in a substantial percentage of female students opting out of mathematics and science careers (Fouad, Hackett, Smith, Kantamneni, Fitzpatrick, Haag, & Spencer, 2010), which in turn greatly affects our nation's ability to supply the STEM workforce (Sadler et al., 2012).

1.2. Theoretical Framework

Social cognitive career theory (SCCT), developed by Lent, Brown, and Hackett (2002), draws primary inspiration from Albert Bandura's work on social cognitive theory (Bandura, 1986). Bandura's framework for learning is grounded in modeling, via observation and recognition of a set of consequences from a learned behavior. The framework posits that learning occurs in a social context and is based on a triadic-reciprocal view of learning as a continuous interaction among personal influences, the environment, and behaviors. Personal influences include self-efficacy, motives, and personality, while environmental influences include role models, relationships, and situations. Finally, behavioral influences include complexity and duration. Collectively, these three variables interact and influence behavior in unequal ways depending on the strength of each influence at any moment in time (Bandura, 1986).

SCCT provides a theoretical model that can be used to understand the career aspirations among students in a high performing STEM-based career academy vocational high school. This theory builds on social cognitive theory to explain three intersecting outcomes: career interest development, career choice, and career performance. In conceptualizing career interest development, SCCT utilizes three major social cognitive variables from Bandura's (1986) work, including self-efficacy, outcome expectations, and personal goals (see Figure 1). SCCT suggests that performance in an academic or occupational arena is contingent upon an individual's ability level, self-efficacy beliefs, outcome expectations, and goals for performance. Individuals are more susceptible to failure when their self-efficacy beliefs are misaligned with their own ability levels, especially if their ability level does not match the ability level necessary to be successful in an academic or occupational setting (Lent et al., 2002).

Self-efficacy is described as the extent to which an individual believes he or she can accomplish something, and is determined by four sources of information or learning experiences: (1) personal performance accomplishments (e.g. successes and failures relating to specific tasks), (2) vicarious learning (e.g. observing similar others), (3) social persuasion (e.g. messages that reinforce or suppress positive experiences), and (4) physiological and affective states (e.g. anxiety induced by specific tasks) (Lent et al., 2002). Regarded as the most influential variable (Bandura, 1986), self-efficacy tends to increase with positive experiences, decrease with repeated failures (Lent et al., 2002), and has a central influence on outcome expectations, career interest, goals, and personal actions, as illustrated in Figure 1.

Outcome expectations refer to a person's personal beliefs about an imagined positive or negative consequence associated with performing a particular behavior or set of behaviors. SCCT posits that a person will be more likely to engage in an activity if they expect that it will lead to a positive outcome (Lent et al., 2002). Outcome expectations involve several types of beliefs about response outcomes, including extrinsic reinforcement, (e.g. rewards associated with success), self-directed consequences (e.g. pride in accomplishing something difficult), and outcomes that result from performing a specific activity (e.g. earning a good grade or getting a promotion) (Lent et al., 2002). Similar to self-efficacy, and as illustrated in Figure 1, outcome expectations are a result of learning experiences and exert a direct effect on the formation of a person's career interests. An individual will pursue an academic opportunity if it is aligned with a person's interests, if the person believes they can accomplish the goal, and if the person believes the outcome will satisfy a specific need or desire.

Goals represent the third major variable within SCCT (Lent et al., 2002). As illustrated in Figure 1, individuals set goals according to their level of self-efficacy, the outcome they expect as a result of their efforts, and based on contextual influences that are proximal to an individual's choices. These proximal influences, which include supports (e.g., role models) and barriers (e.g. microagressions), may affect a person's career interests, career goals, and actions in a way that encourages individuals to pursue a specific career path or abandon their interests and pursue less interesting occupational paths (Lent et al., 2002).

In addition to the social cognitive variables, SCCT also theorizes that career choice is affected by personal inputs, including the social construct – gender. Gender socialization illustrates how a person's educational and career possibilities are influenced by how each gender is treated. For instance, "due to biased access to opportunities for observing and practicing particular behaviors, girls are more likely to develop self-efficacy for female-typed activities such as artwork or domestic tasks and to feel less efficacious at activities that are culturally defined as masculine, such as science or athletics" (Lent et al., 2002, p. 270). SCCT also posits that background contextual influences affect a person's career interests, goals, and actions through personal learning experiences, self-efficacy, and outcome expectations (see Figure 1). Contextual influences include variables such as socio-economic conditions, opportunities for development, and a range of academic and career role models. These influences comprise an opportunity structure (Lent et al., 2002) that has the ability to either foster or hinder the development of career interests and goals through three paths of influence, including formative periods of educational and career development, active periods of educational and career choice making, and finally in translating career interests into goals and then goals into actions (Lent et al., 2001).

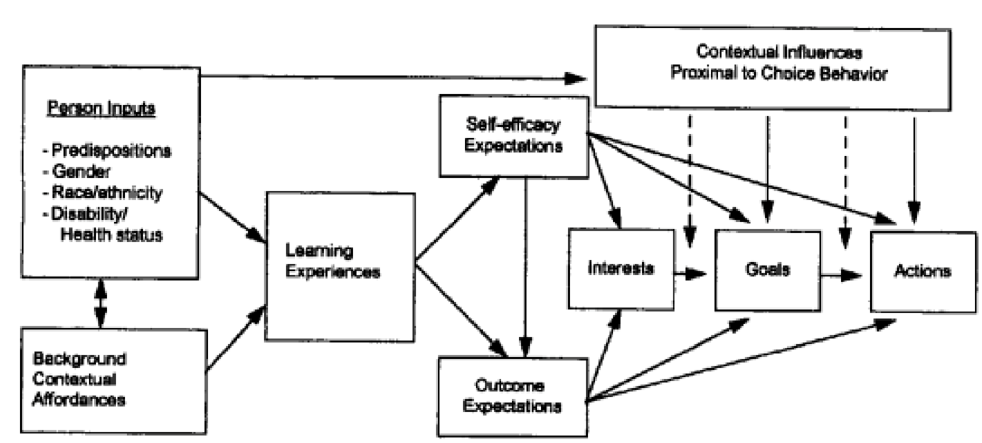

Figure 1. Theoretical model of social cognitive influences on career choice behavior (Lent et al. 1994, 2000).

1.3. Problem Statement and Research Questions

The career aspirations of students at the beginning of high school are the strongest predictor of career aspirations when they leave high school (Sadler, Sonnert, Hazari, & Tai, 2012). National statistics show female students pursuing and persisting in engineering careers at a lower rate than male students. While the decline in females who apply and secure admission into UCMHS provides background context relevant to the ongoing change initiative, this area of inquiry falls outside the parameters of this study. Instead, determining how UCMHS might increase the aspirations of female students to pursue the mathematics-intensive STEM career of engineering once they enter and move through the vocational program is of particular interest and one of the foci of this study. To do this, the theoretical model of social cognitive career theory (SCCT) will be used to investigate the determinants of UCMHS students' engineering career aspirations, including how aspirations change from fall to spring and differ by grade level, gender, and ethnicity.

Over the past two decades, a significant amount of research has been dedicated to understanding the gender gap for females in academic science careers, but the conclusions are inconsistent. A number of research studies indicate that females and males are equally represented in STEM careers, whereas other research studies illustrate a significant gender gap in STEM careers. The research findings do agree, however, that females are well represented in biology, medicine, and the social science careers (Ceci, Ginther, Kahn, & Williams, 2014; Ceci, Williams, & Barnett, 2009; Eccles, 2011, 2016; Heilbronner, 2013). However, females continue to be underrepresented in mathematics-related graduate school programs (Herzig, 2004), the professoriate in mathematics-intensive STEM fields like engineering (Ceci, Ginther, Kahn, & Williams, 2014; Ceci, Williams, & Barnett, 2009; West & Curtis, 2006), and in careers that involve physical, engineering, mathematics, and computer sciences (Eccles, 2011, 2016). Furthermore, there is little research describing the manner in which the gender gap in fields like engineering is influenced by choices made during the high school years, and none that is particular to high performing STEM-based vocational career academy high schools.

This study investigates how factors such as self-efficacy, outcome expectations, personal inputs and backgrounds, and contextual supports and/or barriers predict aspirations for a career in engineering as defined by interests and goals. Specifically, this study analyzes how these factors may contribute to gender differences in choice of an engineering major by students in a high performing STEM-based vocational career academy high school. It is the hope to inform the research on this issue generally and to provide information that can support other high schools with similar STEM programs, develop ways to reduce the gender gap in mathematics-intensive STEM fields like engineering. As such, the following research questions guide this quantitative descriptive study:

1. How do aspirations for an engineering career differ by gender, grade level, and from fall to spring for students within UCMHS?
2. To what extent do the variables identified in social cognitive career theory explain aspirations for an engineering career and differences in these aspirations by gender for students within UCMHS?

1.4. Overview of Methodology

This research study employs a quantitative methodology, using descriptive statistics and multifactorial analysis of covariance to investigate gender differences in career aspirations for engineering and their determinants, including self-reported self-efficacy, outcome expectations, personal inputs, contextual supports, career interests, and personal goals. Descriptive statistics are considered an appropriate tool when looking to "identify characteristics of a group at one point in time or changes in such characteristics across time" (Gall, Gall, & Borg, 2015, p. 203). Further, this study examines how students' aspirations, and key determinants of aspirations, change as students spend more time in a high performing STEM-based vocational career academy high school with a vocational focus on engineering.

Survey. The data for this analysis were collected in the fall and spring of the 2017-2018 school year from administration of a two-part survey (see Appendix A). Part one of the survey asked for students to identify their grade-level, gender identification, and race/ethnicity. Part two of the survey utilized the engineering subsection of the STEM Career Interest Survey (STEM-CIS) developed by Kier, Blanchard, Osborne, and Albert (2014). This survey instrument was developed using social cognitive career theory and utilized a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to measure levels of self-efficacy, personal goals, outcome expectations, contextual supports, personal input, and interest in engineering. Kier, Blanchard, Osborne, and Albert (2014) conducted their study with middle school students, but acknowledged that the individual subsections of their survey could be administered separately and for high school students. The engineering subsection was found to be reliable and valid with a Cronbach's Alpha of 0.86 (Kier et al., 2014).

Survey procedures and representative sample. On October 6, 2017, informed consent letters were sent home via mail to all UCMHS parents inviting their currently enrolled students to participate in the research study. Parents were informed of the purposes of the study, that the children's participation was voluntary, and that all collected data would remain confidential. Of the 304 UCMHS students, 260 agreed to participate in the study. The engineering survey was first administered in the fall and then a second time in the spring of the 2017-2018 school year.

The engineering survey was recreated using Google Forms and sent to each of the four UCMHS vocational teachers. Students completed the survey on district-provided Chromebooks over a period of two days in early October 2017.

Analysis. This study employs a variety of statistical techniques to describe the respondents and the responses to the survey in both the fall and spring of the 2017-2018 school year. Multifactorial analysis of covariance (ANCOVA) is used to test for gender differences in responses in the fall and spring and to test for differences between fall and spring. Comparison of fall and spring results is through analysis of repeated cross-sectional surveys, which is comparable to the comparison of survey responses from political polls at two different times, though it is recognized that in this study there is very little difference in sample composition between fall and spring. This quantitative study uses a statistical software program (IBM® SPSS® Statistics Version 25) for the calculation and analysis of simple descriptive statistics and multifactorial ANCOVAs associated with the variables illustrated in Figure 1, and as operationalized in Figure 2.

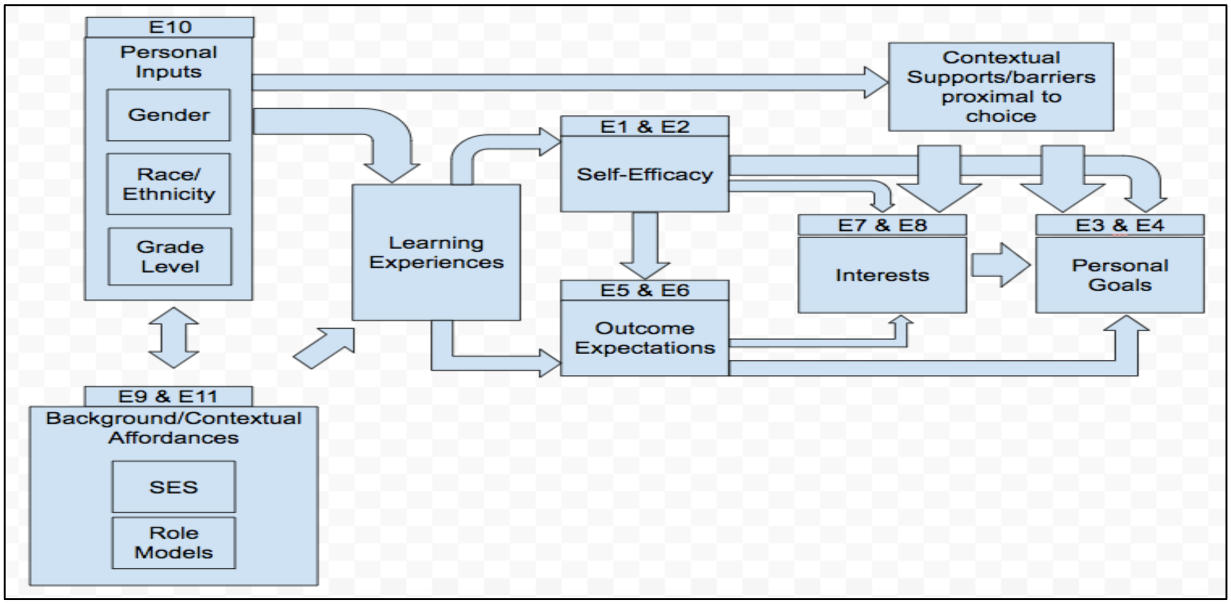

Figure 2. Operational model of social cognitive influences on career choice behavior among students in a high performing STEM-based career academy vocational high school (adapted from Lent et al. 1994, 2000).

1.5. Definition of Key Terms

Barriers. Barriers are "events or conditions, either within the person or in his or her environment, that make career progress difficult" (Swanson & Woitke, 1997, p. 434).

Goals. Personal goals are defined as an individual's "determination or intention to pursue a particular course of action" (Lent et al., 2003, p. 458).

Interests. Interests involve the degree to which individuals enjoy something, and surface when individuals feel efficacious in their ability to be successful and when they believe that engagement in an activity will lead to a valued outcome (Lent et. al., 2015).

Outcome Expectations. Outcome expectations consist of a person's beliefs about the outcomes they are likely to encounter due to a specific course of action, and are the result of a person's learning experiences (Lent et al., 1994; 2002).

Self-Efficacy. Self-efficacy is the extent to which an individual believes he or she can accomplish something (Bandura, 1986).

Background Contextual Affordances. Background contextual affordances, which include a person's socio-economic status, supporting or discouraging gender-socialization messages, and exposure to role models, are factors considered distal to a person's career interests and goals (Lent et al., 2000).

Personal Inputs. Personal inputs, which include factors such as gender, race and ethnicity, and grade-level are factors that can influence a person's learning experiences, which in turn can affect self-efficacy, outcome expectations, and career interest and goals in both direct and indirect ways (Lent et al., 2000).

Communal Orientation. Individuals who express a desire to help people without the expectation of repayment (Clark & Mills, 1993).

Microaggressions. "Microaggressions consist of brief, everyday interactions that send negative messages that are subtle and often ambiguous" (Grossman & Porche, 2014, p. 12).

Chapter 2: Literature Review

Through the lens of social cognitive career theory (SCCT), this literature review identifies the primary reasons for why females are disproportionately represented in mathematics-intensive STEM fields like engineering. The research literature includes a number of social and institutional barriers that have resulted in disproportionately fewer female students pursuing or persisting in mathematics-intensive STEM fields. The cumulative effects of these barriers negatively affect females throughout their educational and professional lives and discourage females from pursuing and persisting in mathematics-intensive STEM fields like engineering (Fouad, Hackett, Smith, Kantamneni, Fitzpatrick, Haag, & Spencer, 2010).

2.1. Scope of the Problem

In the United States, there is a clear gender gap in both starting and persisting in mathematics-intensive STEM fields like engineering. Despite academic enrollment and achievement in mathematics and science remaining relatively equal between males and females, females are choosing career paths in the biological and social sciences rather than in mathematics-intensive fields like engineering. Throughout the past two decades, females have been well represented in postsecondary degree programs that focus on the biological sciences, but remain underrepresented in engineering. For instance, in 1995, females earned 50% of the bachelor degrees in biological sciences, but only 17.3% of the bachelor degrees in engineering. Twenty-years later, these statistics have remained static as females earned 60% of the bachelor degrees in the biological sciences and less than 20% in engineering, with only 1.7% of females earning a bachelor degree in engineering. In 2015, only 14.5% of United States engineers were female (National Science Foundation, 2015).

The lack of females in mathematics-intensive fields can be attributed to a number of social and institutional barriers that have resulted in a phenomenon known as the leaky STEM pipeline. This term has been used to characterize the disproportionately low number of females entering and persisting in STEM careers like physics, chemistry, engineering, and computer science (Falk, Rottinghaus, Casanova, Borgen, & Betz, 2016). Instead, female students are electing to pursue organic STEM fields such as medicine, biology, psychology, and veterinary medicine (Ceci, Ginther, Kahn, & Williams, 2014; Eccles & Wang, 2015) since these fields are typically associated with work that involves people and living things (Falk et al., 2016; Lips, 1992; Wang & Degol, 2013). Moreover, the research literature has shown that the existence of these social and institutional barriers has the potential to negatively affect our nation's ability to compete globally in a STEM workforce (Sadler et al., 2012).

2.2. Explanations for the Lack of Females in Mathematics-Intensive STEM Fields

This dissertation approaches the STEM gender gap problem from the perspective of social cognitive career theory. This theory guided the literature review through a search using the Rutgers database EBSCOhost. Full-text and peer-reviewed text were selected, and then several key phrases were entered, including "Social Cognitive Career Theory," "women in STEM," "wom* in STEM," and "wom* AND STEM" into the search filter. These searches produced 160 studies. Adding "School" and "Barrier" into the search criteria, which resulted in seventeen studies, narrowed the search results. Using these seventeen studies, along with the original 160 studies, Google Scholar was used to continue the search. This strategy proved useful for finding resources, which led to a number of applicable theories, frequently cited authors, and a collection of barriers associated with the gender gap in mathematics-intensive

STEM fields. This search identified both quantitative and qualitative studies that investigate causes for the dearth of females pursuing and persisting in mathematics-intensive STEM fields.

Presentation of the results of the literature review is organized by the key elements of social cognitive career theory. The literature review began with a review of studies that investigated cognitive-person variables. Next, the review of studies examined personal inputs and contextual influences that support or hinder a person's path along the STEM pipeline. Specifically, the extant literature described the interrelated effects of cognitive-person variables (self-efficacy, outcome expectations, and interests and goals), personal inputs (gender and race/ethnicity), and contextual factors considered either proximal (role models and supports/barriers) or distal (socioeconomic status) to the cognitive-person variables. Some of the cited reasons females opt out of mathematics-intensive fields include negative attitudes or beliefs about their ability to be successful, outcome expectations that are misaligned with their personal goals and interests, fewer positive experiences, biased curricula and pedagogy, the existence of a chilly climate, pressure to conform to societal and cultural norms, biological differences between males and females, and an absence of role models (Blickenstaff, 2005).

Self-efficacy. Vocational psychologists have used social cognitive career theory (SCCT) for years to explain the development, interest, and academic pursuits of underrepresented women in specific math-intensive STEM fields such as engineering. SCCT draws largely from Albert Bandura's work on self-efficacy theory (1977) and social cognitive theory (1986). Self-efficacy theory hypothesizes that people complete tasks in specific domains, evaluate the results, and then make judgments about their capabilities in that domain, with failure leading to diminished beliefs and success leading to confidence in their ability. In particular, the more an individual believes he or she can accomplish a specific task, the more engaged that person becomes. Conversely, the less likely a person is to believe he or she can accomplish a specific task, the less engaged they become.

Nearly a decade later, Bandura (1986) developed social cognitive theory (SCT), which posited that people develop beliefs about their capabilities (self-efficacy), which in turn produce specific levels of effort, persistence, and perseverance in the face of difficulty. According to SCT, a person's self-efficacy beliefs develop according to their interpretation of four sources of information, including mastery experiences, vicarious experiences, verbal persuasions, and physical and emotional states. Somewhat earlier, Hackett and Betz (1981) had utilized Bandura's self-efficacy theory to better understand why college women experience low levels of self-efficacy when completing tasks associated with traditionally male-dominated occupations (e.g., engineering), but not in traditionally female occupations, such as teaching. In particular, Betz and Hackett analyzed the manner in which mathematics self-efficacy affected career choice. They found that mathematics self-efficacy, rather than mathematics performance, was a leading predictor in women's pursuit of mathematics-intensive career choices, and found that women had lower levels of mathematics self-efficacy than men (Hackett & Betz, 1989).

Social cognitive career theory was developed when Lent, Brown, and Hackett (1994) partnered to posit self-efficacy and outcome expectations directly impacted a person's interests, which in turn affected career goals and actions, as mediated by a variety of proximal and distal contextual influences, personal inputs, and learning experiences that collectively affect career choices. From Bandura's work in 1977, through the formation of SCCT in 1994, self-efficacy has remained a central construct in the explanation of women's pursuit of and persistence in mathematics-intensive fields like engineering.

Several research studies have investigated the manner in which self-efficacy beliefs affect females' pursuit of and persistence in mathematics-intensive domains. These studies have utilized varied theoretical frameworks and methodologies, and have examined students at multiple grade-levels throughout the education pipeline in an effort to explain the absence of females from mathematics-intensive STEM fields. In particular, a number of important studies have utilized the theoretical lens of social cognitive career theory (SCCT) to illustrate the manner in which career self-efficacy influenced the educational and career choices of female students interested in mathematics-intensive domains. For instance, Lent and colleagues (Lent et al., 2005) investigated 487 students enrolled in an introductory engineering course within three universities, two of which were historically black universities. Using a survey instrument to measure self-efficacy, interests, major choice goals, and social supports and barriers related to the pursuit of engineering, this study found that self-efficacy was a strong predictor of academic interests ($\beta = .30$ at $p < .05$) and the primary predictor of goals ($\beta = .54$ at $p < .05$) in engineering.

A later study, (Lent et al., 2015) used longitudinal data and a survey instrument to measure academic support, self-efficacy, outcome expectations, interests, satisfaction, positive affect, and intended persistence among 732 engineering majors to explain satisfaction and intension to continue in an engineering major. Much like the earlier study, the authors found that self-efficacy was a precursor to outcome expectations (path coefficient of .10 at $p < .05$), whereby students with greater levels of self-efficacy were more likely to believe in greater academic benefits in the field of engineering. The authors also found evidence that self-efficacy was predictive of interest (path coefficient of .09 at $p < .05$), satisfaction (path coefficient of .16 at $p < .05$), and persistence (path coefficient of .18 at $p < .05$). In a study involving 164 Black first-year undergraduate students attending a predominantly White university, Gainor and Lent

(1998) combined SCCT and racial identity theory to study whether racial attitudes affected or moderated self-efficacy, outcome expectations, and sources of efficacy information, interests, and choice intentions in mathematics. The authors found self-efficacy produced a significant path to outcome expectations (path coefficient of .31 at $p < .05$), math-related activities interests (path coefficient of .34 at $p < .05$), and math-related course enrollment intentions (path coefficient of .23 at $p < .05$). In short, the authors found that students would have a propensity to develop positive mathematical outcome beliefs and interests if they were efficacious at mathematical tasks, with self-efficacy having an effect on choice of major when mediated by interest.

In another college study utilizing SCCT, Inda, Rodriguez, and Peña (2013) sought to predict engineering interest and major choice goals among 163 female and 416 male second-year engineering students in Spain by examining the interaction between several of SCCT's central constructs, including the four cognitive-person variables (e.g. self-efficacy, outcome come expectations, interests, and goals) and several contextual supports and barriers in the form of environmental influences that hinder or support career choices. In this study, the authors found female students to have lower mean self-efficacy levels ($M_{SE} = 5.37$; SD = 1.40) than male students ($M_{SE} = 5.88$; SD = 1.48), which in turn was predictive of interest and persistence to continue studying engineering. In short, the female students in this study were less confident in their ability to successfully complete engineering studies.

Bandura's self-efficacy theory (1977) also led to a number of important studies concerning the role of self-efficacy beliefs in the career interests of students in STEM domains. For instance, Hackett, Betz, Casas, and Rocha-Singh (1992) analyzed self-efficacy among 197 first-year or second-year college engineering students finding that academic self-efficacy and occupational self-efficacy ($r = .39$, $p < .001$; $r = .25$, $p < .001$) were both strongly correlated with college academic achievement as measured by cumulative grade point average, as well as interest ($r = .35$, $p < .01$; $r = .39$, $p < .01$).

Lent, Brown, and Larkin (1984) conducted a study that used self-efficacy theory, where 28 male and 14 female undergraduate students were enrolled in a career and educational planning course designed for science and engineering majors used questionnaires pertaining to fifteen science and engineering fields. This study measured two levels of self-efficacy (e.g. level and strength) and persistence as measured by quarters completed. To measure self-efficacy level, the authors analyzed the number of academic requirements and job duties that participants anticipated they could complete. To measure self-efficacy strength, the authors analyzed the degree to which participants' felt confident in their ability to complete the educational requirements and job duties. The authors found that those with a higher self-efficacy level had a higher cumulative grade point average (effect size = 0.84) and technical course grade point average (effect size = 0.68) than those with a lower self-efficacy level. The authors found a similar result with self-efficacy strength, as those with a higher self-efficacy strength had a higher cumulative grade point average (effect size = 1.09) and technical course grade point average (effect size = 0.98) than those with a lower self-efficacy strength. With regard to persistence within a STEM major, the authors found that those with a high self-efficacy level and strength were enrolled in more quarters of technical college than those with a low self-efficacy level (effect size = 1.60) and low self-efficacy strength (effect size = 1.90).

Using a qualitative approach, but through the lens of Bandura's (1986) social cognitive theory, Zeldin and Pajares (2000) used open-ended interviews to determine how self-efficacy beliefs shaped the academic and career choices of fifteen women who selected careers in mathematics, science, and technology fields. They found that vicarious experiences (e.g., watching and learning from others) and verbal persuasions (e.g., encouragement and support from teachers) were the two most influential sources of the women's self-efficacy. This fostered a belief in their ability to be successful in male-dominated domains like STEM. Using Bandura's (1977) self-efficacy theory, along with Holland's (1997) "realistic and investigative interests," Falk, Rottinghaus, Casanova, Borgen, and Betz (2016) used integrative career profiles of 448 potential and declared STEM majors to investigate two themes considered important in explaining females' pursuit of and persistence in STEM domains, namely "realistic skills" (e.g., things-oriented versus people-oriented) and "investigative skills" (e.g., likes to study and solve mathematical challenges). In this study, the authors utilized an online inventory (Betz & Borgen, 2010) to measure self-efficacy and interest with respect to Holland's personality types. While this study revealed no gender differences in investigative, artistic, social, or enterprising self-efficacy and interest measures, the authors did find that female STEM majors were significantly lower than male STEM majors in measures of realistic self-efficacy and interest. Specifically, 60.7% of males fell within the high interest - high confidence quadrant compared to only 19.2% of females. Conversely, 60.6% of females in this study fell in the low interest – low confidence quadrant ($\chi2 < .001$).

In addition to the postsecondary arena, high schools and middle schools are also regarded as a prime opportunity for the investigation of self-efficacy (Hackett et al., 1992) and for exploring where interventions can be designed to foster increased levels of math and science self-efficacy (Fouad et al., 2010). This is especially true in high schools where students are provided opportunities to take advanced coursework like calculus, which is considered important in the pursuit of and persistence in mathematics-intensive careers like engineering (Adelman, 1998). Using expectancy-value theory, Riegle-Crumb and Moore (2013) explored whether gender patterns existed in the high school arena in much the same way gender patterns existed in other locations along the STEM pipeline. With a sample of 20 female and 153 male students enrolled in a new engineering course in six Texas, urban or suburban high schools, the authors investigated student enrollment, personal attitudes towards the field of engineering, and whether any observed differences in attitude towards engineering changed between the beginning and end of the school year. The authors found that female students were an underrepresented population, accounting for only 14% of the students enrolled in the engineering course. When compared to their male peers, female students reported several gender gaps in attitudes that were less favorable, and resulted in lower measures of interest, value, and confidence in engineering skills. For instance, the authors found a significant gender difference in engineering interest (M_{Males} = 4.46; $M_{Females}$ = 3.79; $M_{Difference}$ = .67 at p <.001) and intrinsic value of engineering (M_{Males} = 4.26; $M_{Females}$ = 3.60; $M_{Difference}$ = .66 at p <.001), but a smaller mean difference in confidence (M_{Males} = 4.34; $M_{Females}$ = 4.07; $M_{Difference}$ = .27 at p <.05).

Drawing from a nationally representative longitudinal data set that tracked students over a six-year period from tenth-grade through the declaration of a physical, engineering, mathematics, or computer science major (PEMC), Perez-Felkner, Nix, and Thomas (2017) explored gender differences among 4,450 males' and females' perceptions regarding perceived mathematics ability when presented with challenging content. Using questionnaires to measure the relationships between gender, growth mindset, and perceived ability regarding mathematics when presented with challenging content, students were surveyed in both tenth-grade and twelfth-grade. Findings for both grades revealed that despite observations of equal academic ability among males and females, female students' perceived mathematical ability beliefs, when presented with challenging content, was lower than that of their male peers. Using a two-sample t-test to compare ability beliefs among males and females at the 10th, 30th, 50th, 70th, and 90th percentile of observed ability, the authors found that gender differences in perceived ability in 10th and 12th grade were highly significant ($p < .001$), and that females rated their ability in difficult mathematics lower than males. The authors found that the largest gender differences were found in 10th grade perceived mathematics ability under challenge, with gender differences of 0.29 standard deviations (50th percentile of observed ability), 0.34 standard deviations (70th percentile of observed ability), and 0.24 standard deviations (90th percentile of observed ability). Further, female students who held positive perceptions of their mathematics ability in twelfth-grade had a 5.6% chance of choosing a PEMC major compared to only a 1.8% change for females holding a negative perception of their mathematics ability. In comparison, twelfth-grade male students held a 19.1% chance and 6.7% chance, respectively.

Using intrapersonal attribution theory of motivation, which theorizes that a set of internal and external factors (or locus) can influence a person's motivation (Weiner, 2005), Heilbronner (2013) surveyed males and females who were members of the prestigious Science Talent Search while in high school. In particular, the author administered a pathways survey to investigate the affective, academic, and occupational patterns and experiences of the participants, with a focus on determining whether these patterns and experiences differed for men and women, and whether these differences were present for women from different cohorts. Heilbronner (2013) found that undergraduate male mean self-efficacy subscale scores were significantly higher than undergraduate female mean self-efficacy subscale scores regarding talent and ability to achieve in STEM classes and in the STEM field (effect size = 0.44). The only exception was in measurements of participants' beliefs about their ability to be successful in traditionally female-specific domains (e.g. biology, chemistry, medical science), where undergraduate female mean self-efficacy subscale scores were higher than undergraduate male mean self-efficacy subscale scores (effect size = -0.13).

In a middle school study, Shapiro, Grossman, Carter, Martin, Deyton, and Hammer (2015) explored the predictors of career aspirations among 414 male and 775 female students in sixth, seventh, and eighth-grade. This study also investigated whether Girls Scouts had an effect on its 475 members. Generally, the authors were interested in whether male and female middle school students varied in their respective career interests, aspirations, and goals, and whether these differences were the result of gendered social roles. Using factor analysis, the authors found that males had more positive outcome expectations than females, but that they rated themselves behind both the non-Girl Scouts members and Girls Scouts members in overall mean confidence (M_{Boys} = 10.72; $M_{Non\text{-}GirlScouts}$ = 14.64; $M_{GirlScouts}$ = 16.96), as well as in mean self-confidence leadership pertaining to being in charge (M_{Boys} = 3.50; $M_{Non\text{-}GirlScouts}$ = 5.03; $M_{GirlScouts}$ = 6.17), being responsible (M_{Boys} = 3.96; $M_{Non\text{-}GirlScouts}$ = 5.63; $M_{GirlScouts}$ = 6.35, and being a team builder (M_{Boys} = 2.90; $M_{Non\text{-}GirlScouts}$ = 3.64; $M_{GirlScouts}$ = 4.32). Despite studies finding that membership in Girl Scouts exposed females to social messages that negatively perpetuate gender stereotypes in science (Sadler, Sonnert, Hazari, & Tai, 2012), Shapiro et al. (2015) concluded that single-sex environments have the ability to increase self-confidence, expand career options, and mitigate gendered messages among girls in STEM domains.

Outcome expectations. Bandura (1986) posited that outcome expectations consist of a person's beliefs about the outcomes they were likely to encounter due to specific courses of action. Lent et al. (1994, 2002) took this idea further and suggested that outcome expectations are the result of a person's learning experiences and include several different beliefs about response outcomes. These included extrinsic beliefs, which were related to potential performance rewards, self-directed beliefs, which were extensions of the pride a person experienced when successfully mastering a challenging task, and the outcomes that resulted from the process of performing a specific activity. Further, if a person believed an outcome satisfied a specific extrinsic or self-directed need, and the academic opportunity was aligned with their interests and beliefs concerning their ability to accomplish the goal, a person pursued an academic opportunity. This main idea has remained central to the literature involving outcome expectations for women, particularly in research where the pursuit of and persistence in STEM domains was studied.

Outcome expectations have received considerably less attention than self-efficacy in the study of the gender gap in mathematics-intensive STEM fields (Lent et al., 2003). Several quantitative studies have furthered the role of outcome expectations by using SCCT to study the direct and indirect effects of outcome expectations on a person's academic and career interests and goals, with conflicting results. For instance, Lent et al. (2001) investigated the influence of contextual influences proximal to a person's interest and choice goals by studying 45 male and 66 female first or second-year college students. They found that outcome expectations (R = .59, $R^2 = .35$, $p < .001$) explained an additional 15% of the variance ($\Delta R^2 = .15$) in students' interests beyond self-efficacy (R = .45, $R^2 = .20$, $p < .001$). Social cognitive factors (e.g. interest, self-efficacy, and outcome expectations) collectively accounted for 42% of the variance in choice criterion (e.g. choice of major and course enrollment intentions), with outcome expectations (along with self-efficacy) accounting for 7% of the variance. Further, the effect of outcome expectations on participants' choice intentions was found to be both direct and indirect through interests, whereas the effect of self-efficacy on participants' choice intentions was only indirect.

Similar findings were found by Lent et al. (2005), who studied 70 female and 150 male primarily first-year engineering students attending two historically black universities (one private and one state), along with 52 female and 214 male primarily first-year engineering students attending a predominantly white university. In particular, the authors set out to analyze the engineering interests and choice of major among males and females. Using a ten-question survey instrument ($\alpha = .91$) that measured outcome expectations via a 10-point scale, the authors found that participants from the two black universities reported significantly higher levels of outcome expectations than those attending the predominantly white university. When combined into a single group, outcome expectations and self-efficacy across each of the three schools accounted for 37% of the variance in engineering interests. These findings are in line with an earlier study involving 164 black undergraduates Gainor and Lent (1998), which found outcome expectations and self-efficacy accounted for 28% of the variance in interest, with outcome expectations explaining an additional 5% of the variation in interest beyond what was explained by self-efficacy.

In an international study, Inda et al. (2013) analyzed engineering interest and major choice goals among 163 female and 416 male engineering students in Spain. The authors found that outcome expectations for males and females were related to interests ($r_{males} = .24$, $p < .001$; $r_{females} = .26$, $p < .001$) and academic goals ($r_{males} = .37$, $p < .001$; $r_{females} = .33$, $p < .001$). This study also found that outcome expectations did not differ significantly between males and females. For males and females, outcome expectations influenced interests ($\beta_{males} = .31$, $p < .001$; $\beta_{females} = .18$, $p < .001$) and goals ($\beta_{males} = .20$, p < .01; $\beta_{females} = .15$, $p <.01$).

Using Bandura's (1977) self-efficacy theory, Hackett et al. (1992) analyzed 149 male and 48 female predominantly first or second-year engineering students to identify the relationships between cognitive variables and academic achievement within engineering programs. The authors found that positive and negative outcome expectations were among the strongest predictors of academic self-efficacy ($r_{positive} = .39$, $p < .01$; $r_{negative} = -.24$, $p < .001$). Further findings showed a correlation between positive outcome expectations and interests ($r = .33$, $p < .01$), negative outcome expectations with stressors ($r = .41$, $p < .001$), positive outcome expectations with coping ($r = .17$, $p < .01$). Using a 12-question survey instrument that assessed students' perceptions along a 10-point scale, females reported lower mean positive outcome expectations than males (effect size = -0.33), but higher mean negative outcome expectations (effect size = 0.35).

Conversely, two quantitative studies yielded evidence that there is no direct path from outcome expectations to interests and goals. In one study that utilized both SCCT and SCT, Lent et al. (2003) analyzed 66 female and 248 male college students enrolled in an introductory engineering design class to study whether perceived contextual supports and barriers explained the choice goals and actions of engineering students. While self-efficacy produced paths to interests ($\beta = .61$, $p < .05$) and goals ($\beta = .44$, $p < .05$), and accounted for 38% of the variation in interests, outcome expectations did not yield independent paths to interests and goals, as the authors found no significant variation in interest beyond self-efficacy. Similarly, in a study that utilized SCCT, Lent et al. (2008) analyzed 166 male, 37 female, and six unidentified first and second-year engineering students. In this study, the authors used a longitudinal study to determine whether outcome expectations, self-efficacy, interests, and goals changed in their interaction with one another over time. While the survey instrument found small but significant lagged paths from self-efficacy to participants' outcome expectations ($\beta = .17$, $p < .05$), interests

($\beta = .13$, $p < .05$), and goals ($\beta = .15$, $p < .05$), results found no evidence to suggest outcome expectations directly affected participants' interests and goals.

Interests and personal goals. Interests involve the degree to which individuals enjoy something, such as a school or a work activity, and surface when people feel efficacious in their ability to be successful in an academic or vocational task. Interests also surface when individuals believe that engagement in an activity will lead to a valued outcome (Lent et. al., 2015). Personal goals, which are influenced directly or indirectly by self-efficacy, outcome expectations, contextual influences, and interests, are defined as an individual's "determination or intention to pursue a particular course of action" (Lent et al., 2003, p. 458). In particular, personal goals are established according to an individual's level of self-efficacy, the outcome they expect as a result of their efforts, and a number of contextual influences that serve as either supports or barriers to an individual's academic and career interests (Lent et al., 2002). Career interests and personal goals have long been the target of inquiry among vocational psychologists in search of reasons for females' absence from mathematics-intensive STEM domains.

Interests and goals have been regarded as an influential factor in participants' pursuit of STEM opportunities while in high school and the most influential factor in the selection of a STEM occupation (Heilbronner, 2013). Several studies have investigated student interests and goals in mathematics-intensive domains throughout high school and postsecondary education, with mixed results. While some studies have demonstrated that interest is not an antecedent to mathematics-intensive career goals (Lent et al., 2008), several studies have shown that interest does relate to personal goals, particularly for high school students (Heilbronner, 2013; Riegle-Crumb & Moore, 2013) and college engineering students (Gainor, 1998; Inda, 2013; Sadler, 2012). For instance, in a study involving 173 high school students, Riegle-Crumb and Moore

(2013) made connections between the lack of interest in engineering among the female participants in their study, relative to the male participants in their study, and the patterns that are evident in the broader literature with respect to the lack of females in postsecondary engineering programs. Using a survey instrument ($\alpha = .81$) to measure mean interest in engineering at the beginning and end of an engineering course, the authors found a significant gender difference in mean interest in engineering ($\Delta M = .67$, $M_{males} = 4.46$, $M_{females} = 3.79$, $p < .001$) at the beginning of the school year. While interest in engineering accounted for the largest gender gap decrease within their study ($\Delta M = -.28$) by the end of the course, it was only marginally significant ($p < .07$).

Several postsecondary studies have examined the interaction between interests and goals. For instance, in an early study involving 164 black university students, Gainor and Lent (1998) used a survey instrument ($\alpha = .90$) to measure student interest in math and science related activities, as well as the affect interest had on math-related course enrollment and math-related choice of major. The authors found a strong correlation between interests and choice of major ($r = .37$, $p < .001$), as well as a direct path from interests to choice of major (path coefficient of .22, $p < .05$). In an international study involving 579 engineering students in Spain, Inda et al. (2013) used a survey instrument ($\alpha = .82$) to measure student interest in performing engineering-related activities. In doing so, the authors found a significant correlation between interests and goals for both males and females ($r_{males} = .25$, $p < .001$; $r_{females} = .29$, $p < .001$), and that interests directly influenced goals for both males and females ($\beta_{males} = .10$, $p < .05$; $\beta_{females} = .21$, $p < .01$). In a much larger, retrospective study, involving 2,584 male and 2,668 female undergraduate students in pursuit of a STEM career, Sadler (2012) utilized a survey instrument to determine how interests changed for males and females over the course of their high school career. At the beginning of high school, engineering attracted the career interest of more males (n = 674; 26.1% of the males) than females (n = 94; 3.5% of the females) for a male to female percentage ratio of 7.5:1. By the end of high school, engineering attracted the career interests of more males (n = 766; 29.6%) than females (n = 135, 5.1%), but the male to female percentage ratio decreased from 7.5:1 to 5.8:1.

Females' interests and personal goals have also been related to academic self-efficacy (Hackett et al., 1992), as well as gender and socio-economic status (Myers, Jahn, Gaillard, & Stoltzfus, 2010). For instance, in an early study involving 197 postsecondary engineering students, Hackett et al. (1992) utilized an *interest in engineering* scale ($\alpha = .79$) to determine students' interest in 18 engineering-related occupations, as related to self-efficacy. The authors found that females had a lower mean interest in engineering than did males (effect size = -0.3), along with as a strong correlation between interest and occupational self-efficacy ($r = .39$, $p < .01$).

In a qualitative study involving 241 junior high school and high school students, Myers et al. (2010) used focus groups and a semi-structured interview protocol to determine likes and dislikes with regard to mathematics and sciences classes, as well as how others' (e.g. parents, teachers, etc.) comments about gender appropriate careers affected the participants' career plans. The authors found "strong support for the role of gender as well as culture and/or SES in the development of academic and career interests… [as well as an indication] that gendered and cultural prescriptions played a role in how they view[ed] math and science classes and future careers" (p. 99). The research literature illustrates that these constructs are guided by females' preference for a family-work balance that allows flexibility to accommodate childrearing responsibilities (Wang & Degol, 2013), as well as a desire to satisfy an affinity for working with people rather than objects (Eccles, 2011; Lips, 1992; Riegle-Crumb & Moore, 2013; Wang & Degol, 2013).

Personal inputs. In 2015, President Barack Obama made one of his many public statements acknowledging the affect STEM fields have on the United States' push for global advancement (Obama, 2015). His message underscored the importance of developing, growing, and sustaining a workforce that would compete globally in science, technology, and engineering fields. In particular, his message called for future workers to be prepared with the critical thinking and problem solving skills necessary to become leaders in innovation and research. Despite this call to action, demographic projections continued to illustrate a diminished pool of qualified candidates entering mathematics-intensive scientific fields, highlighting a need to include substantial numbers of women and minority workers who have historically shied away from career paths in science, technology, and engineering (Dasgupta, Scircle, & Hunsinger, 2015; Oakes, 1990). The disproportionately low number of women and minorities represented in STEM remains a critical obstacle to the success of our nation's goal to be competitive in a global economy (Leaper, Farkas, & Brown, 2012; Oh & Kim, 2015). In support of this issue, social cognitive career theory provides a lens that includes personal inputs (e.g. gender and race/ethnicity) and background contextual affordances (e.g. socio-economic status) as factors that can mitigate or perpetuate the leaky STEM pipeline phenomenon. In particular, these variables influence a person's learning experiences, which in turn affect self-efficacy, outcome expectations, and career interest and goals in both direct and indirect ways.

Gender. A number of studies have sought to better understand the role of social attributes (e.g. gender and race) in the development of academic achievement and educational and occupational choices among males and females in the area of mathematics-intensive STEM domains. In a large study involving 7,204,843 students in grades two through eleven, and from ten different states, Hyde, Lindberg, Linn, Ellis, and Williams (2008) analyzed state assessment data and found that mathematics skills in grades two through eleven for female students were on par with their male peers and that female students were enrolled in advanced mathematics courses at a more equal rate than in the past. The authors found that effect sizes were < 0.10, with 21 indicating a performance advantage by males, 36 indicating a performance advantage by females, and nine indicating a performance advantage by neither males nor females. These data collectively resulted in a weighted mean of 0.0065, evidence that there exists no gender difference in mathematics performance between males and females, which strongly refutes the notion that such a difference explains why fewer females choose to pursue mathematics-intensive courses as some have suggested.

Data from the National Assessment of Educational Progress (NAEP) from the Nation's Report Card website (2015) is used to partially explain this phenomenon. NAEP measures levels of student interest and enjoyment in mathematics, reading, and science-related topics and activities. Data from grades four, eight, and twelve shows that more males than females report mathematics and science as their favorite subjects, while more females than males report reading as their favorite activity. Males' propensity to show interest and enjoyment in mathematics and science activities has led researchers to explore the legitimacy and accuracy of gender and racial academic achievement gaps.

These findings are supported by a survey study involving nearly 1200 middle school students across three states, including 414 boys, 775 girls. Shapiro et al. (2015) set out to determine if gendered social roles affected boys' and girls' career interests, aspirations, and goals. The authors found that 73% of the boys and 55% of the girls believed there were jobs for which boys were better equipped than girls, and both boys and girls were able to correctly predict the top choice of the opposite sex (e.g. boys = STEM and athletes; girls = arts and medicine). Additionally, 26.1% of the boys chose a STEM career, in comparison to 12.4% of girls, and 31% of girls anticipated a break from work when having children, in comparison to 4% of boys. These findings illustrate the manner in which socialized gendered roles and messages influence the thinking and planning of middle school students, as girls' career expectations continue to be focused on relational values (e.g. making the world a better place, childrearing, etc.).

Recognizing the competing claims of biological and sociocultural causes as explanations for the dearth of females in STEM, Ceci et al. (2009) brought clarity to this area of inquiry by identifying four main factors within the research literature that broadly explained the unique nature of females' underrepresentation in mathematics-intensive domains. First, they found that math-proficient females preferred non-mathematics intensive careers or that they chose to leave mathematics-intensive careers as they advanced. Secondly, the authors found that fewer women than men scored in the extreme math-proficient range on critical gatekeeper tests, such as the Scholastic Aptitude Test (SAT) in mathematics and quantitative reasoning sections of the Graduate Record Exam (GRE). Third, females with high levels of mathematics competency were found to have high levels of verbal competency, which resulted in additional career opportunities. Finally, the authors found that females with children were penalized in the workforce, particularly through a lack of lack of promotions. Conversely, the authors found that institutional barriers and stereotypes failed to account for a majority of the sex differences in mathematics-intensive domains. Instead, gender differences were explained by lifestyle choices (e.g. childrearing responsibilities) and preferences for a career in medicine, teaching, or law, rather than in engineering or physics. These findings remain consistent with studies that show females are more likely than boys to temporarily stop work (Shapiro et al., 2015) and place more value on family needs (Eccles, 2011; Eccles & Wang, 2015).

Using mathematics and science standardized exam data from the 2003 Trends in International Mathematics and Science Study (TIMSS), Nosek et al. (2009) utilized social identity threat theory to determine if there were performance-stereotypes among a sample of 300,000 eighth-graders from 34 countries. For science achievement, boys held a median advantage over girls by 9.5 points, and that boys averaged significantly higher science achievement than girls in 65% of the countries. Further, using data from an Implicit Association Test (IAT), the authors found that "national implicit stereotyping of science as male was strongly related to national sex differences in 8^{th}-grade science performance (r = 0.60, 95% confidence interval)" (p. 10594), with a one standard deviation increase in implicit stereotyping increasing boys' science score advantage by 6.3 points (an effect size of 0.56). This study provided support for the argument that females who associate math and science with boys, through socio-cultural contexts, were prone to like these subjects less, pursue these career paths less, and perform worse on standardized math assessments in comparison to males.

In a related study, Eccles (2011) utilized expectancy-value theory in the study of 1000 high school seniors to determine if they differed in their career aspirations in a predictable gender-stereotype manner due to gender-role stereotyped socialization. The author found that valuing others predicted male and female plans to enter human service or biological sciences and health-related fields. Specifically, females placed more value than males on the importance of making occupational sacrifices for one's family and on the importance of having a job that allowed them to help others and do something worthwhile for society. Further, the author found that the socialization of both males and females continued to provide predictable gender patterns in the choices of occupational pathways. Despite females' desire to live integrated lives (e.g. parenthood and career), discrimination and harassment in the workplace, as well as messages of disapproval from colleagues, friends, and family, perpetuated negative thoughts about entering male-dominated occupations, resulting in more gender-approved occupations (e.g. working with people).

These findings were supported by a study that involved 4,411 women working between the ages of 25 and 43 (Nsiah, DeBeaumont, & Ryerson, 2012). The authors identified five occupational categories, including technical occupations (4.3% of the population), sales (9.4% of the population), administrative support/clerical (25.9% of the population), service (19.3% of the population), and blue-collar jobs (13.2% of the population). While technical occupations earned the most, the authors found that a wage penalty existed for women that ranged from 7.6% (administrative support/clerical occupations) to 23.2% (service occupation) below that of the technical occupations ($p < .001$), not accounting for children. For instance, mothers in sales earned 5% less per child, while mothers in technical occupations who earned 1.2% less per child. As an explanation, mothers were thought to be worn out from the responsibilities associated with motherhood, had to conserve energy, and were considered "more irrational [and] less committed to their positions, less productive, more likely to leave their current employment, less reliable, and less likely to go above and beyond the call of duty due to other commitments" (p. 225). These experiences illustrated the "chilly climate" feeling that has been felt by females in several male-dominated professions.

Intersection of race and gender. A number of studies illustrate the unique affect that both race and gender have on student experiences, particularly for Black and Hispanic students.

For instance, Oakes (1990) demonstrated that minority students are most at risk for being targeted for special education courses or courses designed to provide intervention and remediation, both of which may not afford students the ability to be exposed to challenging material. These decisions perpetuate the education gap that exists between minority students and their white peers, especially in the areas of science and mathematics. These earlier findings have been substantiated by a number of recent studies that have explored the intersection of race and gender in an effort to better understand the gaps in mathematics and science achievement and attitudes. Quinn and Cooc (2015) conducted a large study that investigated the gender and race/ethnicity trends in science test scores among a nationally representative sample of 21,409 students followed from kindergarten through eighth-grade, with a secondary purpose of determining how much of the science gap in eighth-grade could be explained by various factors, including socio-economic status. Findings demonstrated that females scored significantly lower than males on standardized science exams in grade three (SD = -0.23, $p < .001$), grade five (SD = -0.25, $p < .001$), and grade eight (SD = -0.19, $p < .001$). The authors also found a large and constant-over-time science achievement gap in standardized science exam scores among White and Black students, as Black students scored significantly lower than White students in grade three (SD = -1.07, $p < .001$), grade five (SD = -1.12, $p < .001$), and grade eight (SD = -1.10, $p < .001$). While not as severe, Hispanic students also scored significantly lower than White students on standardized science exams in grade three (SD = -0.85, $p < .001$), grade five (SD = -0.69, $p < .001$), and grade eight (SD = -0.65, $p < .001$). When controlling for socioeconomic status in grade 8, the authors found little effect on the gender gap ($SD_{without\ SES} = -0.185$, $p < .001$ vs. $SD_{with\ SES} = -.186$, $p < .001$), but the Black-White science achievement gap ($SD_{without\ SES} = -1.07$, $p < .001$ vs. $SD_{with\ SES} = -0.80$, $p < .001$) and the Hispanic-white science achievement gap

($SD_{without\ SES}$ = -0.66, $p < .001$ vs. $SD_{with\ SES}$ = -0.31, $p < .001$) both reflected achievement gap reductions.

In an earlier study utilizing 2003 Program for International Student Assessment data (PISA), Cheema and Galluzzo (2013) also sought to predict mathematics achievement using socio-economic status (SES) along with gender and race. Among a sample of 4,733 White, Black, and Hispanic high school students, multiple regression analysis revealed persistent racial and socioeconomic gaps in math achievement. While Whites outperformed both Blacks and Hispanics in mathematics achievement, there were larger mathematics achievement gaps among Whites and Blacks (r = -0.33, $p < 0.001$) than among Whites and Hispanics (r = -0.19, $p < 0.001$). Socio-economic status (SES) revealed a moderately positive association (r = 0.45, $p < 0.001$) with mathematics achievement, while one-way ANOVA testing revealed a significant difference in mathematics achievement between males (effect size = 0.09), although gender by itself was not found to be an important predictor of mathematics achievement (R^2 = 0.002).

Around the same time, Else-Quest, Mineo, and Higgins (2013) utilized expectancy-value theory to investigate gender differences in mathematics and science attitudes and achievement among 367 White, African-American, Latino-American, and Asian-American tenth-grade students. Ability self-concept (How good are you at math/science?), task value (How important do you think math/science will be to you in the future?) and expectations of success (How successful do you think you'd be in a career that required math/science ability?) were measured with instruments (α = 0.79 to 0.95) that utilized Likert scales. Academic achievement was measured using end of course math and science grades, with weights applied to honors and advanced placement courses. This study found that gender was not a significant factor in end of year math or science achievement (d = 0.10 to d = -0.29), whereas ethnicity was significant. In particular, Asian-American students outperformed the other ethnic groups "in both math, $F(3,290) = 9.79$, $p < .001$…and science, $F(1,293) = 2.07$, $p = .15$" (p. 299). On the other hand, gender differences in math and science attitudes did not vary across ethnic groups.

Background contextual affordances. In addition to cognitive-person variables (self-efficacy, outcome expectations, and personal goals) and personal inputs (e.g. gender, race/ethnicity), background contextual affordances can also influence career interests and goals. Considered distal to a person's career interests and goals, these environmental factors "affect the learning experiences through which career-relevant self-efficacy and outcome expectations develop" (Lent, et al., 2000, p. 37). Background contextual factors include a person's socio-economic status, supporting or discouraging gender-socialization messages related to academic and extracurricular activities, and exposure to role models.

Socioeconomic status. Socioeconomic status (SES) has been utilized by social scientists to examine aspects of child development for decades. Regarded as a construct that encompasses both economic position and social status, SES has often been measured using family income, parental education, and occupational status (Bradley & Corwyn, 2002). SES, as a central measure of background contextual affordances considered distal to a person's career interests and goals, has proven particularly useful in better understanding how the family dynamic accounts for the underrepresentation of women in mathematics-intensive STEM fields. Not only have high SES family backgrounds fostered gender-atypical behaviors among girls (Schoon, 2001), the family unit has been a top source of academic support (Bandura, Barbaranelli, Caprara, & Pastorelli, 2003), efficacy development (Schoon & Polek, 2011) and career interest development (Myers, Jahn, Gaillard, & Stoltzfus, 2010).

Using focus groups to interview 241 high school students, Myers et al. (2010) found that academic and career interests were strongly related to familial culture and socioeconomic status, and that parents were the most significant source of a student's aspirations. This work supports the findings of an earlier study conducted by Bandura et al. (2001), which found that families with a higher socioeconomic status expressed stronger beliefs in their own efficacy to promote their children's academic development. In a much larger study involving two representative samples of British participants born between 1958 and 1970, Schoon and Polek (2011) used structural equation modeling to study the association between gender, family background, general cognitive ability, teenage career aspirations, and career attainment of more than 11,000 individuals. The authors found that family social status, as measured by a combination of the father's occupational social class and level of education, was significantly associated with childhood cognitive ability, as measured by IQ exams. Background played a significant role in shaping career development among males and females, with males and females from disadvantaged backgrounds less likely than those from advantaged backgrounds to pursue a professional career. Specifically, family social status explained 14% to 19% of the variance in cognitive ability (path coefficients = .38 to .44, $p < .001$, SE = .16 to .34), 10% to 14% of the variance in level of education (path coefficients = .32 to .38, $p < .001$, SE = .01 to .05), and 3% to 6% of the variance in occupational aspirations (path coefficients = .18 to .25, $p < .001$, SE = .00 to .01) for males and females in both cohorts. These findings supported a study conducted by Chen (2009), which included over 9,000 students interviewed in 1995, 1998, and 2001 as part of the Beginning Postsecondary Students Longitudinal Study. Among dependent students who entered a STEM field between 1995 and 2001, a larger percentage were from a family income in the top quarter (28%) than bottom quarter (26%), especially in biological/agricultural sciences (top quarter =11%, bottom quarter = 8%) and engineering sciences (top quarter =11%, bottom quarter = 9%).

Gender socialization messages. Social cognitive theory has been used to illustrate the manner in which parents contribute to a gender-socialization among children, particularly through observation, behavioral enactment, and motivation. Familial beliefs are affected by demographic factors, such as socioeconomic status, whereby lower socioeconomic status often results in access to fewer resources and academic connections. These are critical to the promotion of learning opportunities in mathematics and science for children, where gender-socialized messages exerted influence over students' values, interest, and beliefs about careers in STEM as stated by Wang & Degol (2013). As parents encouraged children to pursue specific activities, such as science, children learned about and considered the benefits of engaging in content (Bandura, 1986). Parents and teachers often displayed gender-biased behaviors when it came to the expectations they held regarding their children's mathematics competencies. In turn, these biased behaviors influenced the attitudes and self-perceptions of children, which then led to a belief that mathematics and science ability was associated with males rather than females (Gunderson, Ramirez, Levine, and Beilock, 2012).

The effects of gender-socializing messages have been studied for decades across multiple educational levels. For instance, in a qualitative study that utilized focus groups with 241 high school students, Myers et al. (2010) demonstrated students' views of math or science careers were strongly influenced by familial gender-socialized cultural beliefs. These findings were supported a few years later in a mixed-method approach involving 1024 students enrolled in one of five STEM-focused high schools, one of which was an engineering high school. Grossman and Porche (2014) used surveys and semi-structured interviews to measure perceived levels of support. Students reported strong familial and teacher support for STEM success: 53% reported feeling supported in their STEM success, with 30% experiencing support specific to their gender and 36% specific to their race/ethnicity. However, 67% of the female students experienced gender-role expectations that suggested STEM careers were for males rather than females.

Leaper et al. (2012) employed a quantitative study that involved a sample of 579 middle school, junior high school, and high school girls. This study utilized a survey instrument (α = .67 to .87) that included gender identity, which included a measure of perceived parental pressure (e.g. My parents would be upset if I wanted to learn an activity only boys usually do), and perceived academic support (e.g. How much have you personally felt supported and encouraged to do well in science?). The authors found that girls' motivation in mathematics/science was positively associated with both the mothers' math/science support (r_s = .22, $p < .001$) and the fathers' math/science support (r_s = .26, $p < .001$). Girls' math/science grades were also positively associated with fathers' math/science support (r_s = .28, $p < .001$). Conversely, girls' math/science motivation was negatively associated with age (r_s = -0.24, $p < .001$) and parental pressure to conform to traditional gender roles (r_s = -0.17, $p < .001$), while girls' math/science grades was negatively associated with age (r_s = -0.41, $p < .001$) and parental pressure to conform to traditional gender roles (r_s = -0.12, $p < .01$).

In a smaller quantitative study, Tenenbaum and Leaper (2003) investigated the family as a central context in the gender typing of science achievement among 26 sixth-grade students and 26 eighth-grade students. A questionnaire was utilized to collect several measures, including parents' rating of their children's scientific interest (My child finds science very boring/very interesting) and parents' rating of their children's scientific ability measuring difficulty (My child finds science very easy/very hard) and effort (To do well in science, my child has to try a little/a lot). The authors found that parents of sons were more likely than parents of daughters to believe that their child was interested in science (effect size = 1.0) and that parents of daughters were more likely than parents of sons to believe that science was difficult for their child (effect size = 0.62).

Role models. Role models have the ability to persuade or dissuade students from specific academic avenues through a variety of means, either intentional or unintentional. As defined by Haveman and Wolfe (1995), “role models are adults or peers to whom children or adolescents relate and who set norms of behavior and achievement to which they aspire” (p. 1834). While role models can surface within either sex, research has shown that it is the quality of the interaction that matters more than the sex of the role model (Zeldin & Pajares, 2000).

Educators are reflected as a primary source of role models in the research literature, and are considered to be strong role models for young female students because they have significant influence over student development and future success (Haveman & Wolfe, 1995). However, this development is often affected by the degree to which young female students believe they are capable of succeeding in a particular academic setting. The amount of uncertainty in young female students, regarding their academic ability, can potentially diminish their chances of finding academic success in the future. For this reason, role models have been shown to play an important mitigating role. “The amount by which the uncertainty is reduced will be a function of how closely the student can identify with her role model and how easily she can envision herself achieving what her role model has achieved” (Nixon & Robinson, 1999, p. 186). This illustrates the manner in which a teacher can positively influence females and minority students to actively pursue STEM oriented activities. Teachers as role models often hold the key to influencing a student’s decision to pursue academic opportunities in one direction or another (Dee, 2005).

Teachers have also been a source of support for both females and males in math and science classes from middle school through college (Fouad et al., 2010). This suggests that exposing more school-aged females to STEM role models (Wang & Degol, 2013) or even same-race role models (Lent et al., 2005) may increase females' interest in pursuing and persisting in mathematics-intensive STEM fields.

Same-gender role models. Increasing the presence of female role models to attract more females to mathematics-intensive STEM fields has been hypothesized with results revealing varying degrees of effectiveness. For instance, Betz and Sekaquaptewa (2012) conducted a quantitative study with 144 sixth-grade and seventh-grade middle school females to determine if feminine STEM role models would weaken future plans to study mathematics. Students were asked to report their favorite subject, of which 78 (54%) identified as STEM-identified (e.g. students who selected math, science, or both). Students then read computer-based interviews with female university students depicted as role models displaying either feminine or gender neutral characteristics. Within the study, *feminine* role model characteristics were considered those wearing makeup and pink clothes, reading fashion magazines, regarded as an engineering star, and praised by Chemistry faculty. Gender-neutral role model characteristics were considered those wearing glasses and dark-colored clothing, enjoyed reading, regarded as a freshman star, and praised by field-unspecified faculty members. Finally, students completed a survey that measured their perceived similarity to the role models, their intention to take mathematics courses in high school and college, their mathematics self-rating, and the role model's positivity. The authors found that "role-model-femininity by domain interaction was significant for STEM-disidentified girls [those who did not select math, science, or both as their favorite subject], $F(1, 133) = 10.23$, $p < .01$, $d = .55$, but not STEM-identified girls, $F < 1$" (Betz

& Sekaquaptewa, 2012, p. 4). In other words, feminine STEM role models decreased the likelihood of STEM-disidentified girls selecting math classes once in high school or college, and made the girls feel less capable and less interested in math. Moreover, STEM-disinterested girls were less likely to believe that they could achieve both the STEM success and the feminine role models' level of femininity, meaning they were unlikely to perceive a congruency between femininity and pursuing a STEM career.

The notion of *feminine* role models have also been found to have a negative effect on high school females' pursuit of mathematics-intensive STEM fields. Using a socio-cultural perspective, Bamberger (2014) qualitatively explored the perceptions high school females' had of female scientists and engineers, how they perceived their own STEM capabilities, and what their tendencies were in the pursuit of a STEM career. The authors set out to determine whether perceptions would change after visiting a high-tech Israeli company that employed female scientists and engineers. The author identified 60 ninth-grade females as the experimental research group and an additional 30 ninth-grade females as the control group. The experimental group participated in a program that included an opening activity at the students' school, two visits to the high-tech company, and a summary meeting at the students' school, while the control group did not participate in the program. The opening activity allowed the female scientists and engineers to describe themselves and their work at the company, while the two visits provided time for lectures, laboratory visits, and interactions with laboratory materials involving chemical reactions, and space and materials. At the end of the program, findings revealed that the experimental group felt frightened, less inclined to pursue a STEM career, and experienced a significant decrease in their positive view of female scientists and engineers after attending the program. The control group, which did not attend the program, did not experience these changes.

In a much earlier qualitative study, Zeldin and Pajares (2000) utilized open-ended interviews, involving 15 females employed in a STEM career, to better understand that factors that contributed to the selection, persistence, and success in a math, science, or technical career. The authors found that female role models were not a requirement for the female's entry into a STEM career. Instead, the females reported that it was the quality of the interaction between themselves and the role model that mattered more than the sex of the role model. Further, the females recalled being more attentive to the encouragement of those with whom they had forged close relationships, including several teachers who they recalled as being caring and encouraging, regardless of gender.

The results of Bamberger (2014) and Zeldin and Pajares (2000) countered this research literature that showed an important reason for the dearth of females in mathematics-intensive STEM fields is a lack of female scientists and engineers as role models (Blickenstaff, 2005). For instance, Stearns et al. (2016) conducted a large quantitative study using the North Carolina Roots data set. This data set provided longitudinal data on academic performance for all North Carolina public schools from seventh grade through college graduation. With a sample that included 16,300 college-bound students entering one of 16 University of North Carolina colleges in 2004, the authors set out to test whether a high school's math and science faculty demographics was associated with a college students' selection of a STEM major and graduation with a STEM degree. The authors found a positive and significant relationship between the probability of college females selecting a STEM major and the ratio of male and female high school science teachers (probit coefficient = .84, $p < .05$, SE = .33). Additionally, the authors found that the college females had a greater chance to graduate with a STEM degree if they attended a secondary school with more female than male math and science teachers (probit coefficient = .90, $p < .05$, SE = .41). Further, the authors found that White females were more likely to select a STEM field major (probit coefficient = .87, $p < .05$, SE = .43) and graduate with a STEM degree (probit coefficient = .99, $p < .05$, SE = .47) when they graduated from high schools with a higher proportion of female mathematics and science teachers. No significant relationship existed between the demographic composition of high school faculty and White or African-American males', or with African-American females' pursuit of and persistence in a STEM major.

Communal role models and socially relevant interventions. Another explanation for the dearth of women in mathematics-intensive STEM fields involves the gender-stereotype that females prefer communal orientations, while males prefer agentic orientations. Individuals who express a desire to help people without the expectation of repayment are said to hold communal orientations (Clark & Mills, 1993). Individuals who prefer communal orientations are attracted to careers that involve helping others or working with people, while agentic orientations are favored by those who are assertive and attracted to status (Diekman, Brown, Johnston, & Clark, 2010; Diekman, Clark, Johnston, Brown, and Steinberg, 2011; Tellhed, Bäckström, & Björklund, 2018). Females who disassociate with mathematics-intensive STEM fields tend to perceive these fields as being in conflict with their preferred communal orientations, which partially explains the degree to which females pursue more communally oriented fields like teaching or the biological sciences within STEM.

Several studies have investigated the manner in which males and females have been guided by either communal or agentic orientations, with a particular focus on how communal orientations affect a female's pursuit and persistence in male-dominated STEM fields. For instance, Fuesting and Diekman (2017) conducted a multi-part quantitative study that involved 149 students, 52 of whom were STEM majors. In the preliminary study, the authors investigated the participants' perceptions of the scarcity of communal role models in STEM and non-STEM fields by examining the predictive nature of communal and agentic orientations on investigative vicarious learning experiences. Participants were asked to consider four STEM careers (mechanical engineering), three stereotypically male careers (lawyer), and three stereotypically female careers (education), after which they were asked to respond (not at all challenging to extremely challenging) to a prompt that was identical for each career (how challenging would it be to find a professor or teaching assistant role model in a [blank] career?). Participants were also asked to rate six communal behaviors (support and help from others; pursue work that benefits the community) and four agentic behaviors (have high status, successful in their field). Their study found that communal role models were perceived as being more difficult to find in STEM careers than in male-stereotypic careers (effect size = 0.16) and female stereotypic careers (effect size = 0.50), with higher mean ratings an indication that role models were more difficult to find. In short, the authors found that participants perceived communal role models as difficult to find in STEM careers (M = 3.85, SD = 1.34, $p < .05$), while agentic role models were perceived as difficult to find in female-stereotypic careers (M = 3.67, SD = 1.40, $p < .05$).

A number of college level studies have shown a disassociation between STEM careers and communal orientations (Diekman, Brown, Johnston, & Clark, 2010; Diekman, Clark, Johnston, Brown, and Steinberg, 2011). For instance, in conducting a multi-part survey study involving several hundred students enrolled in an introductory psychology course, Diekman et al. (2011) investigated whether gender differences were larger in communal or agentic goal orientation, and whether beliefs and associations about STEM careers would be considered an impediment to communal goals. To determine whether gender differences were larger in communal or agentic goal orientation, the authors had 318 students rate the importance of different communal (serving humanity, attending to others, etc.) and agentic goals (power, financial success, etc.) using a seven-point scale (not at all important to extremely important). Findings revealed that women reported a stronger disassociation of communal orientation from STEM fields, as women endorsed communal goals more than men [F (1,316) = 35.72, p <.0001, d = -0.67]. Conversely, men endorsed agentic goals more than women [F (1,316) = 3.07, p <.08, d = 0.21].

To determine whether beliefs and associations about STEM careers would be considered an impediment to communal goals, Diekman et al. (2011) had 75 students rate the likelihood that various careers, which included STEM careers (mechanical engineer), non-STEM male-stereotypic (CEO), and female-stereotypic (teacher), would fulfill either communal goals (intimacy, altruism, etc.) or agentic goals (power, achievement, etc.). In comparison to non-STEM male-stereotypic and female-stereotypic careers, STEM careers were perceived as affording significantly less communal goals [F (2, 146) = 107.89, p < .001, $[\text{eta}]_G^2 = .39$]. This study provided evidence that STEM careers are perceived as disassociated from communal orientation (Diekman et al., 2010), which partially explained why females were dissuaded from pursuing a number of STEM fields. Moreover, this study also found that the activation of communal goals resulted in a decrease in STEM interest among males and females, but that tasks involving work with and for others produced thoughts among females that included the pursuit of scientific careers.

In a study that utilized longitudinal survey data from 935 high school students, Blanchard Kyte and Riegle-Crumb (2017) investigated the role played by social relevance in furthering boys' and girls' interest in STEM, particularly in biology, physical science, computer science, and engineering majors. Using gender theory and science education as a theoretical lens, the authors found that females are less likely than males to pursue a STEM major in the aggregate ($B = -0.88$, $SE = .14$, $p < .001$), which is consistent with the research literature. However, the authors found a statistically significant increase in the percentage of females interested in a STEM major when science was seen as being socially relevant ($B = .93$, $SE = .46$, $p < .05$). Further, the authors analyzed males' and females' predicted probabilities of expecting to major in STEM as a function of their perceptions of science being socially relevant. As the perceptions of science being socially relevant increased, the average probability of females expecting to pursue a STEM major increased from approximately 40% (1 standard deviation below the mean) to approximately 55% (1 standard deviation above the mean), whereas males remained unchanged at just below 70%.

Communally driven interventions have been a topic of inquiry among researchers interested in shifting females' perceptions of traditionally agentic fields. Schools have been considered viable arenas for implementing these types of interventions due to their smaller culture and general ability to affect change more effectively than larger institutional and social cultures (Diekman, Steinberg, Brown, Belanger, & Clark, 2017). A number of studies have explored the manner in which communal interventions affect student perceptions of STEM fields. For instance, in a quantitative study involving 791 middle school students, Weisgram and Bigler (2006) divided participants into several groups. One group consisted of 617 female students assigned to a science intervention program called *Expanding Your Horizons*, which was a conference designed to increase females' interest in STEM. The four-hour program included hour-long sessions in earth science, engineering, computer science, math and science, and biology and medicine, and included presentations by female scientists and engineers. In addition to the presentations, the females were engaged in science-related activities. However, within this experimental group, 319 of the 617 female students were in sessions that referenced altruistic characteristics, where the presenter talked about how their science career helped others. Using surveys that measured a number of constructs, the authors found a significant difference between altruism in females (M = 3.49, SD = .436, effect size = -0.40, $p < .01$) and in males (M = 3.29, SD = .572, effect size = -0.40, $p < .01$), but no differences in altruistic value between the females who attended presentations about scientific careers that helped people, and those who were not part of that treatment group.

In a study involving fifth-grade and sixth-grade female students in an all-girls school, Colvin, Lyden, and Leon de la Barra (2012) designed a series of hands-on civil engineering activities to determine whether communal goals and values would lead females to become attracted to civil engineering careers. For instance, students designed a water transportation device, a water purification device, a tall structure, and a bridge. In each activity, students were prompted to consider how design and material use positively or negatively affected varies communities. For instance, the use of inexpensive materials was considered an important factor in designing the water transportation activity for a poverty-stricken environment. In the water purification task, students discussed the importance of clean water to societal safety, as well as the utility of a low-cost filtration system that could be used in underdeveloped countries. The tall structure and bridge building tasks required students to consider the local environment, particularly the balance between environmental impact, cost, and community utility. While females from both grades viewed civil engineers in gender-stereotypical ways prior to the intervention (e.g. men who fix things with tools), all students viewed the civil engineering field differently after the intervention. In particular, students referenced the field as one defined by teamwork and helping people live better lives.

2.3: Strengths of the Contributing Factors

Social cognitive career theory, an often-cited theoretical lens within the STEM gender-gap research literature, is useful for explaining the manner and strength with which various factors contribute to the leaky STEM pipeline phenomenon. The literature generally points to a lack of academic and social support, debilitating gendered messages that suggest certain career paths are more appropriate for males than for females, and a variety of cognitive person variables that have direct and indirect effects on a person's vocational pursuits.

Nevertheless, two areas within the research literature are frequently cited as offering strong and promising solutions for addressing the STEM gender-gap in mathematics-intensive career paths. First, low levels of self-efficacy among females appears to be a factor most responsible for the STEM gender-gap problem, as it is the most cited explanation for the general lack of females in traditionally male-dominated STEM fields. Described as the extent to which an individual believed he or she can accomplish something, self-efficacy is determined by several factors, including a person's learning experiences and personal performance accomplishments, observing others, exposure to positive or negative social messages, and physiological and affective states associated with anxiety (Lent et al., 2002). Considered one of the most influential variables within social cognitive career theory, self-efficacy is a critical factor because it tends to increase with positive experiences and decrease with negative experiences. Further, and perhaps more importantly, self-efficacy exerts both direct and indirect influence on many of the social-cognitive career theory variables cited within the STEM gender-gap literature, including outcome expectations, career interest, personal goals, and personal actions. As a result, self-efficacy remains one of the strongest, most critically research areas within the STEM gender-gap research literature.

Communal interventions, including access and exposure to communal role models, are an area of inquiry quickly emerging in the STEM gender-gap research literature. Since communally oriented careers often attract people interested in helping or working with people, communal orientations have the possibility of becoming one of the most tangible targets for high school interventions whose aim is to increase females' interest in mathematics-intensive fields. A number of studies have shown that providing opportunities for females to engage in communal activities within mathematics-intensive STEM fields can result in significant changes in student behavior. These behavioral changes have been found to include a newfound sense of belonging within STEM fields (Fuesting & Diekman, 2017) as well as an increased level of positivity with respect to becoming a scientist (Colvin et al., 2012; Diekman et al., 2011).

2.4: High School as a Potential Solution

The research literature on the gender gap in mathematics-intensive STEM fields has predominantly focused on students in postsecondary programs or on those already in the STEM workforce. This literature has investigated the manner in which females' self-efficacy, outcome expectations, interests and goals, and contextual supports have either supported or hindered students' pursuit of or persistence in the STEM pipeline. However, the research literature is limited when it comes to the manner in which high schools serve as a potential intervention to the leaky STEM pipeline phenomenon. This is especially concerning to a principal of a high-performing engineering high school. However, within this limited field of inquiry, the research literature offers evidence of successful interventions that educators should consider when attempting to promote engineering as a viable career path for females. In particular, a growing body of literature suggests that communally oriented interventions have the ability to increase females' self-efficacy, shift beliefs about outcome expectations, and increase interest among those who do not initially see mathematics-intensive STEM fields as contributing to society in meaningful ways. This work is promising since individuals with communal orientations are interested in helping others or working with people (Diekman, Brown, Johnston, & Clark, 2010; Diekman, Clark, Johnston, Brown, and Steinberg, 2011; Tellhed, Bäckström, & Björklund, 2018). More specifically, interventions that enable females to make communal connections within mathematics-intensive STEM fields may offer a potential solution to reducing the gender gap among males and females in mathematics-intensive STEM fields.

Colvin et al. (2012) illustrates one particular middle school intervention that has merit for use in high school settings, particularly specialized engineering high schools. Colvin et al. (2012) used a series of hands-on civil engineering activities to determine if communal goals and values foster interest among female students in civil engineering. The activities charged students with developing several communally oriented projects, including a water purification device and building a structure for a needy community. In doing so, students were challenged to consider how their design and choice of material either positively or negatively affected the community they were seeking to help. An important outcome from this intervention was that students viewed the field of civil engineering differently after participating in the activity. Specifically, students recognized that the field of civil engineering was defined by teamwork and involved helping people live better lives, both of which are important tenants of a communal orientation.

In a high school study, Blanchard Kyte and Riegle-Crumb (2017) investigated the manner in which social relevance furthered students' interest in STEM fields like biology, physical science, computer science, and engineering. Similar to the findings of Colvin et al. (2012), the important implication from this study was that the authors found a significant increase in the percentage of females interested in a STEM major when science was seen as being socially relevant. Among females, the average probability of expecting to pursue a STEM major increased from approximately 40% to 55% as the perception of science being socially relevant increased. These statistics illustrate that high schools would be wise to consider increasing access to communal role models, and to establish interventions that involve the development and implementation of STEM curricula that include communal orientations and socially relevant activities.

2.5 Strengths and Limitations of the Research Literature

The research literature widely acknowledges that females have gone from being underrepresented in all STEM careers to being well represented in biology, medicine and the social sciences. Nonetheless, despite recent gains and equal academic standings, females continue to lag behind their male counterparts in mathematics-intensive STEM fields like engineering (National Science Foundation, 2015; Eccles, 2011). For decades, the research literature has been evidenced with qualitative and quantitative studies that have identified the leading causes of the gender gap in mathematics-intensive STEM fields. A review of this research literature indicates numerous factors that have explained the gap or contributed to its growth, many of which can be explicated using social cognitive career theory. The literature is strong in identifying the underlying factors, such as cognitive-person variables (e.g. self-efficacy, outcome expectations, and career interests/goals), personal inputs (e.g. gender and race/ethnicity) and background contextual supports (e.g. role models and socioeconomic status) that affect student-learning experiences in unidirectional and bidirectional ways. However, the studies are limited with respect to how the underlying factors are associated with students in the high school setting.

Self-efficacy remains the strongest and most widely cited factor associated with the dearth of females in mathematics-intensive STEM fields. While mostly quantitative in nature, the research base contains a wide range of sample sizes with varied effect sizes. In one of the strongest studies associated with the leaky STEM pipeline phenomenon, Lent et al. (1984) found that those with higher self-efficacy levels had a higher cumulative grade point average (effect size = 0.84) and technical course grade point average (effect size = 0.68) than those with lower self-efficacy levels. Similarly, those with higher self-efficacy strength had a higher cumulative grade point average (effect size = 1.09) and technical grade point average (effect size = 0.98) than those with lower self-efficacy strength. These finding were supported by a larger quantitative study, involving 360 undergraduate students, whereby Heilbronner (2013) also found strong support for self-efficacy being a critical factor in the leaky STEM pipeline phenomenon. Heilbronner found that self-efficacy was higher among males than females (effect size = 0.44), with the exception of those who considered their ability to be successful in traditionally female career paths such as biology and medical sciences, where the effect size was -0.13.

The research literature is also strong in its review of outcome expectations as a central factor within the leaky STEM pipeline phenomenon. Hackett et al. (1992) found that positive outcome expectations were among the strongest positive predictors of academic self-efficacy ($r = .39$, $p < 0.01$), with negative outcome expectations yielding a strong negative correlation to academic self-efficacy (r = -0.24, $p < 0.001$). Similarly, the authors found a strong correlation between outcome expectations and interests (r = .33, $p < 0.01$), between negative outcome expectations and stress (r = 0.41, $p < 0.001$), and a moderate correlation between outcome expectations and coping (r = 0.17, $p < 0.01$). Moreover, the authors found that females reported a lower average score in positive outcome expectations than did males (effect size = -0.33), and higher average negative outcome expectations than did males (effect size = 0.35).

The research literature is also strong in its support of role models, particularly the affect they have on females' pursuit of and persistence in mathematics-intensive STEM fields like engineering. The research literature illustrates that role models can be either male or female, and can serve to reduce or perpetuate the gender gap in various ways, with communal role models and behaviors serving as one of the strongest sources of positive influence among female students. The research findings also indicate that the presence of a supportive STEM network, which can include peers, parents, educators, and community members, can mitigate the effects of poor self-efficacy among females across all levels of education. Nonetheless, the vast majority of research literature investigates the manner and degree to which cognitive-person variables, personal inputs, and contextual factors influence students to either pursue or withdraw from various STEM fields during or after their postsecondary education experience.

There exists a significant gap in the research literature regarding the manner in which self-efficacy, outcome expectations, personal inputs, and contextual supports predict aspirations among females in the K-12 arena, particularly for students within specialized STEM career academy high schools. This study seeks to fill that gap in the research literature by investigating how self-efficacy, outcome expectations, interests and goals, personal inputs and backgrounds, and contextual supports predict aspirations for a career in engineering among students in a high performing STEM-based vocational career academy high school. The goal is to inform the literature pertaining to the STEM gender gap, generally, and to inform best practices locally and among other high schools with similar STEM programs in order to develop ways to reduce the gender gap in mathematics-intensive STEM fields like engineering.

Chapter 3: Methodology

The research literature pertaining to the gender gap in mathematics-intensive STEM fields addresses a number of social and institutional barriers that result in fewer females than males pursuing and persisting in career paths such as engineering. This research base, which includes quantitative and qualitative studies, through the lens of various theoretical frameworks, is limited since it includes samples from predominantly post-secondary settings. The research on this important national dilemma would benefit from studies that include students in the high school setting, particularly those that employ specialized curricula that focuses on engineering, as this might provide a more complete picture of where, when, and why students leave the STEM pipeline.

3.1. The District Setting

The Union County Vocational-Technical School District (UCVTS) is located in the suburban town of Scotch Plains, New Jersey. The campus has five full-time career-academy high schools, each with its own specific vocational focus. These academies include The Academy for Allied Health Sciences (AAHS), The Academy for Information Technology (AIT), The Academy for Performing Arts (APA), The Magnet High School (MHS), and The Union County Vocational-Technical High School (UCTECH). The first four academies have a vocational focus in health-related services, information technology and business, performing arts, and engineering, while UCTECH offers several different vocational programs, including masonry, carpentry, plumbing, electrical, and automotive technologies. UCTECH also offers a series of career pathways, including clinical care sciences, law and justice, exercise physiology, architectural design, sustainable sciences, and teacher education. For each of the five full-time career academies, students graduate with a high school diploma and an industry recognized vocational certificate.

Students are admitted from one of twenty-one municipalities in Union County, New Jersey based on a rigorous admissions process. Students begin this process by attending a mandatory information session during the fall of their eighth-grade year. Students and parents are given an overview of the district's honors-level academic program, which exceeds state requirements in nearly every curricular area. This includes three years of study in world language, and four years of study in mathematics and science. These sessions also include specific information about each career academy's vocational program, and then conclude with information about the admission's process. Families are informed that students are admitted according to a process that ranks students based on a composite score generated from middle school grades and performance on UCVTS's mathematics and English language arts literacy admissions exams. The composite scores are ranked from highest to lowest for each municipality with the top five students from each municipality guaranteed their first choice of career academy. Once the top five students from each municipality are admitted into their preferred school, the remaining students are placed into their second or third choice, as determined by rank order. This procedure continues until approximately twenty-five students from each municipality are placed. Due to the four-year vocational sequence within each school, students are not permitted to transfer to another school on campus once enrolled.

Staff Demographics. During the 2017-2018 school year, there were 113 teachers across the five full-time career academies, 50 categorized as non-tenured and 63 categorized as tenured (see Table 1). The district gender split favored females at 64.6% (73/113), with UCTECH having the largest single percentage of female teachers at 76.9% (20/26). All schools employed more female teachers than male teachers. Furthermore, each building employed two administrators, a principal and a teaching supervisor. Each school employed between two and three counselors.

Table 1.

Staff Demographics for Full-Time Academies

School	Total Teachers	Male/Female	Total Non-Tenured Teachers	Total Tenured Teachers	# Counselors	# Administrators
AAHS	22	7 / 15	9	13	2	2
AIT	25	10 / 15	9	16	2	2
APA	16	6 / 10	8	8	1	2
MHS	24	11 / 13	8	16	2	2
UCTECH	26	6 / 20	16	10	3	2
DISTRICT	113	40 / 73	50	63	10	10

(UCVTS, 2018. Observation Matrix. Unpublished internal document. UCVTS)

Student Demographics. During the 2017-2018 school year, UCVTS enrolled 1,557 full-time students from across twenty-one municipalities in Union County, New Jersey (see Table 2). Two of the schools (AIT and MHS) had more male students than female students, and in all five schools, white students represented the largest student demographic. In three of the five schools, the Asian population represented the second largest demographic. The percentage of students regarded as economically disadvantaged, as determined by membership in the free/reduced lunch program, ranged between 8.2% and 15.9%. The special education population was relatively small, ranging from 1% to 3.4%. The district received special education services through the Union County Educational Services Committee.

Table 2.

Student Demographics for Full-Time Academies

School	Enrollment	Male/Female	White	Black	Hispanic	Asian	Economically Disadvantaged	Special Education
AAHS	296	30% / 70%	38.9%	15.5%	17.9%	26.0%	13.2%	1%
AIT	293	70% / 30%	48.5%	8.2%	17.7%	23.2%	8.2%	3.4%
APA	223	13% / 87%	47.1%	15.2%	29.6%	3.6%	13.5%	1%
MHS	304	57% / 43%	38.5%	8.6%	15.5%	35.2%	12.2%	1%
UCTECH	441	34% / 66%	45.8%	18.8%	24.5%	9.3%	15.9%	1.1%

(*New Jersey School Performance Report*, 2018)

Academic Achievement. During the 2017-2018 school year, UCVTS maintained its national position as a high-performing high school district. Each school on campus was nationally ranked among the top 791 high schools in the nation, with three high schools ranked among the top 81 in the nation (MHS, AAHS, and AIT), and one high school ranked among the top 19 in the nation (MHS) ("America's Best High Schools," 2018).

As a reflection of academic achievement, students were high performing (see Table 3). As a reflection of PARCC scores, at least 95% of the students in each high school met or exceeded expectations for English language arts literacy achievement, with two schools reaching 100%. In mathematics, at least 95% of the students met or exceeded expectations in three of the five schools. As a measure of college and career readiness, both the SAT and ACT subject tests indicated strong student achievement. SAT mean math scores ranged from 582 to 714, while SAT mean reading & writing scores ranged from 605 to 686. Collectively, these results were all well above the state mean for math (543) and the state mean for reading and writing (542). Similarly, with the ACT subject tests, school mean scores across all schools exceeded the state mean scores in reading (24), English (24), math (24), and science (23) (*New Jersey School Performance Report, 2018*)

Table 3.

Academic Achievement for Full-Time Academies

School	PARCC ELA	PARCC Math	SAT Reading/Writing	SAT Math	ACT Reading	ACT English	ACT Math	ACT Science
AAHS	100%	95.2%	675	685	31	32	30	29
AIT	98.8%	96.6%	665	685	29	31	29	28
APA	95%	75%	605	582	28	27	26	25
MHS	100%	99.2%	686	714	32	33	32	31
UCTECH	98.8%	80.5%	609	612	27	26	25	24

(*New Jersey School Performance Report*, 2018)

3.2. UCMHS Background Context

In 2015, I was appointed principal of Union County Magnet High School (UCMHS). Shortly after my appointment, I developed an interest in determining whether or not the curricular program encouraged students to pursue a career path in engineering. Unfortunately, several examinations of the academic program guide revealed only one engineering course (chemical engineering), and the core vocational program was grounded in architecture. Within a few months, our school engaged in a curricular reform project geared towards developing engineering courses that would merge the academic content with meaningful hands-on experiences. After working with students, staff, and a variety of other key stakeholders during the first year, curricula for five new electives, including civil engineering, electrical engineering, electric vehicle engineering, aerospace engineering, and environmental engineering, were developed.

Following the development of curricula for five new electives, the school established a relationship with several organizations that provided the students with opportunities for communal interactions. First, the school partnered with the New Jersey Society of Women Engineers (NJSWE) as part of an after school STEM program. During this time, 25 female students were part of a 30-minute panel discussion along with a 90-minute breakout session that engaged female students in a variety of hands-on engineering projects. One project called for students to work in teams to design and build a functional prosthetic device out of a variety of low-tech supplies, including yarn, cardboard, and tape. Throughout the evening, NJSWE spoke of the social and communal relevance associated with their daily work and how it furthered their interest in engineering. Secondly, the school partnered with the Arc Kohler School, a special needs school in Union County, New Jersey. Through this partnership, students had the opportunity to work with the occupational therapist to design and manufacture a number of devices that provided functionality and social mobility for physically disabled students. Perhaps the most communally oriented project involved a partnership between UCMHS students and UCTECH students. This project called for students to transform a 55-passenger school bus into a mobile library, which will be shipped to Ghana, Africa to provide educational access to students across the region. UCMHS and UCTECH students conducted a number of virtual meetings with the representative from Ghana and are currently in the early stages of the design process. Most evident in the process was the manner in which students saw how engineering has global benefits that can affect humanity in profoundly positive ways.

The curricular change was evidenced with both positive and negative consequences. First, during the 2016-2017 school year, with only one year of planning, the school anticipated offering only one section of each elective. Enrollment totals for civil engineering and electrical engineering required an additional section for each course, a sign that the electives generated student interest. Civil Engineering and Electrical Engineering included 46 students and 49 students respectively, with 33% of each class being female. Similarly, Environmental Engineering included 21 students, with 38% of the class being female. Conversely, Electric Vehicle Engineering, Aerospace Engineering, and Chemical Engineering enrolled smaller percentages of females, with 25%, 15%, and 29%, respectively. Statistically, the percentage of females in 4 of the 5 electives was above the 19.8 % national average for women earning an engineering bachelor degree, an indication that our curricular reform generated interest amongst the female students in our building.

Conversely, there was one negative consequence associated with our curricular change. Prior to the class of 2020, enrollment data showed gender composition being relatively evenly distributed with 46% of the student body being female. The class of 2020 marked a significant shift, relative to the current student body, with only 35% of the class being female (see Table 4). Furthermore, prior to the class of 2020, gender composition ranged from 41% to 53% female. The class of 2020 marked the largest gender gap across the five cohorts of students, with data trending toward the national statistics associated with the dearth of females in mathematics-intensive STEM fields. Therefore, while there was success in creating a set of engineering courses, an enrollment dilemma presented itself where fewer females are now choosing to attend the school.

Table 4.

2017-2018 SY: Total Population - Union County Magnet High School

Grade	Male	Female	Total
Class of 2022	46 (61%)	29 (39%)	75
Class of 2021	47 (64%)	26 (36%)	73
Class of 2020	50 (65%)	27 (35%)	77
Class of 2019	38 (47%)	43 (53%)	81
Class of 2018	45 (57%)	34 (43%)	79
Class of 2017	42 (59%)	29 (41%)	71
Class of 2016	36 (55%)	30 (45%)	66
Totals (7 Years)	161 (54%)	136 (46%)	297

(UCVTS, 2018. Unpublished internal document. UCVTS)

3.3. Sample

The sample for this study includes 304 students who were enrolled in UCMHS during the 2017-2018 school year, of whom 172 were male (56.6%) and 132 were female (43.4%). Student enrollment data by grade-level enrollment consisted of 70, 77, 80, and 77 for the class of 2018 through the class of 2021, with female student enrollment for these years consisting of 29 (41.4%), 33 (42.9%), 43 (53.8%), and 27 (35.1%), respectively. The incoming class of 2022 includes 29 (37.7%) female students, data that are more in line with both the class of 2021 female student enrollment record as well as national statistics that indicate engineering is a male-dominated field. As evidenced by these data, UCMHS has experienced a noticeable decline in the number of female students admitted into the school, particularly for the classes of 2021 and 2022, which are the two classes that entered UCMHS after the curricular changes were implemented.

3.4. Research Questions and Hypotheses

This problem of practice dissertation seeks to better understand the career aspirations of students currently enrolled in a specialized career academy vocational high school where the curricular focus is in engineering. To gain insight into this problem of practice, the following research questions and hypotheses guide this quantitative descriptive study:

Research Question 1. How do aspirations for an engineering career differ by gender, grade level, and from fall to spring for students within UCMHS?

Hypothesis 1a. UCMHS student aspirations (interests and goals) for a career in engineering will differ by gender.

Hypothesis 1b. UCMHS student aspirations for a career in engineering will be higher in the spring than in the fall.

***Hypothesis 1c*.** UCMHS gender differences in aspirations will be lower in the spring than in the fall.

***Hypothesis 1d*.** UCMHS student aspirations will differ by grade level.

Research Question 2. To what extent do the variables identified in social cognitive career theory explain aspirations for an engineering career, and differences in these aspirations by gender, for students within UCMHS?

***Hypothesis 2a*.** Levels of outcome expectations, self-efficacy, background contextual affordances, and personal inputs among UCMHS students will predict aspirations for a career in engineering, as defined by interests and goals.

***Hypothesis 2b*.** UCMHS student gender differences in the levels of outcome expectations, self-efficacy, background contextual affordances, and personal inputs will result in gender differences in aspirations for a career in engineering.

***Hypothesis 2c*.** UCMHS student strengths in the relationships of outcome expectations, self-efficacy, background contextual supports and personal inputs will result in gender differences in aspirations for a career in engineering.

***Hypothesis 2d*.** The determinants of aspirations among UCMHS students will differ by grade level.

3.5. Research Design

This research study utilizes a quantitative methodology to investigate gender differences in career aspirations for engineering and their determinants, including self-reported self-efficacy, outcome expectations, personal inputs, contextual supports, career interests, and personal goals. Descriptive statistics, including mean, median, mode, and standard deviation, will be calculated. As cited by Gall, Gall, and Borg (2015), descriptive studies are appropriate when looking to identify how a group's characteristics change over time. Additionally, separate multifactorial ANCOVAs assessing all main and 2-way interaction effects were conducted for interests and goals to test Hypotheses 1a – 1d and Hypotheses 2a – 2d.

Data Collection. The data for this analysis were generated in the fall and spring of the 2017-2018 school year from administration of the engineering subsection of the STEM Career Interest Survey (STEM-CIS) developed by Kier, Blanchard, Osborne, and Albert (2014). This survey was developed using social cognitive career theory to measure self-efficacy, personal goals, outcome expectations, career interest, and contextual supports across science, technology, engineering, and mathematics. While the survey authors conducted their study with middle school students, they acknowledged that the subsections of their survey for each field, including engineering, could be administered separately and indicated that the survey also would be appropriate for high school students. The engineering subsection of their survey instrument was found to be reliable and valid with a Cronbach's Alpha of 0.86 (Kier et al., 2014).

The survey instrument administered contained two parts (for the full instrument, see Appendix A). Part one of the survey asked three background questions regarding grade, gender identification, and race/ethnicity. Part two of the survey, which was adopted in full from the engineering subset developed by Kier et al. (2014), utilized a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to measure self-efficacy, personal goals, outcome expectations, contextual supports, personal input, and interest in engineering.

Sample and survey procedures. On October 6, 2017, informed consent letters were sent home to all UCMHS parents via mail inviting their currently enrolled students to participate in this research study. Parents were informed that the purpose of this research study was to investigate gender differences in career aspirations for engineering, with an aim to examine how students' aspirations, and key determinants of aspirations, may change as they spend more years in an engineering vocational program. Parents were further informed that this information would contribute to research that might inform schools, parents, and others about how to reduce the gender gap in the engineering STEM pipeline. Lastly, parents were informed that student participation was voluntary, that students could withdraw at any time without penalty, and that all collected data would remain confidential.

Of the 304 UCMHS students, 260 returned signed informed consent forms indicating a desire to participate in the study. The engineering survey used in this study was administered twice to all 260 eligible UCMHS students in the fall and spring of the 2017-2018 school year, which included 72 out of 77 freshmen, 70 out of 80 sophomores, 62 out of 77 juniors, and 56 out of 70 seniors. The engineering subsection of the survey (Kier et al., 2014) was recreated using Google Forms, labeled *2017-2018 Engineering Career Interest Survey*, and then sent as a hyperlink to each of the four UCMHS vocational teachers on Wednesday, October 11, 2017. The four vocational teachers' classes were selected since all students are required to take four years of vocational coursework. Since the campus functions on an A/B block, meaning students either have their vocational course on A-day or B-day, approximately half of the students were expected to complete the survey on Thursday, October 12, 2017, while the remaining students were expected to complete the survey on Friday, October 13, 2017.

Within each email, the four vocational teachers were given instructions to post the engineering survey to their respective Google Classroom so that the 260 eligible UCMHS students would have access to complete the survey during class time. Google Classroom functionality allowed the four vocational teachers to make it accessible to only those students eligible to participate in the research study. Using district issued Chromebooks, 256 out of 260 eligible students completed the survey, with 242 completions within four days and an additional 12 completions by October 30, 2017. This process was repeated in the spring, whereby the four vocational teachers were sent an email on May 7, 2018 containing a hyperlink to a second version of the engineering survey, labeled *2017-2018 Engineering Career Interest Survey_Post_Assessment.* As modeled in the fall, teachers were asked to upload the survey link to their Google Classroom and administer the survey to the 260 eligible students on Tuesday, May 29, 2018 and Wednesday, May 30, 2018. For this administration, 254 of the 260 eligible students completed the survey, with 224 responses within the first four days and the remaining 30 responses by June 14, 2018.

Data Analysis. This study will employ a variety of statistical techniques to describe the respondents and the responses to the engineering survey instrument – all of the variables in Figure 2 – in both the fall and spring of the 2017-2018 school year. Multifactorial analysis of covariance (ANCOVA) assessing all main and 2-way interaction effects will be conducted to test for gender differences in responses in the fall and spring, and to test for differences between fall and spring. Comparison of fall and spring results is through analysis of repeated cross-sectional surveys, due to the guarantee of anonymity of an individual's survey responses that cannot be linked between fall and spring. This is comparable to the comparison of survey responses from political polls at two different times, though it is recognized that in this study there is very little difference in sample composition between fall and spring. This quantitative analysis uses a statistical software program (IBM® SPSS® Statistics Version 25) for the calculation of the simple descriptive statistics and the multifactorial ANCOVAs associated with the variables illustrated in Figure 1, and as operationalized in Figure 2.

Chapter 4: Analysis and Research Findings

This chapter presents the findings of a quantitative research study that addresses two research questions intended to better understand the career aspirations of students currently enrolled in a specialized engineering-based career academy vocational high school. First, this chapter includes a measures section that provides an overview of the key variables associated with social cognitive career theory (see Figure 1). The measures section also details the internal reliability and correlations among the survey questions. Secondly, this chapter presents the findings of a series of ANCOVAs intended to test this research study's operational model (see Figure 2), which was used to identify gender differences in engineering career aspirations. This study utilized the engineering subsection of a STEM Career Interest Survey (STEM-CIS) developed by Kier, Blanchard, Osborne, and Albert (2014). The survey instrument included fourteen total questions, of which the first three included personal input questions for gender, race and ethnicity, and grade-level. The remaining questions included two questions each for background contextual affordances (E9 and E11), self-efficacy (E1 and E2), outcome expectations (E5 and E6), interests (E7 and E8), and goals (E3 and E4) (see Appendix A).

4.1. Measures

This study utilized social cognitive career theory (Lent et al. 1994, 2000) to investigate how factors such as self-efficacy, outcome expectations, background contextual supports, and personal inputs predicted aspirations for a career in engineering, as defined by interests and goals. Moreover, this study analyzed how these factors contributed to potential gender differences in choice of an engineering major among students in Union County Magnet High School, a high-performing STEM-based vocational career academy high school. This section begins with an overview of each variable within the operational model, beginning with the two measures associated with aspirations for a career in engineering.

Goals. Goals represent one of three major constructs within social cognitive career theory (SCCT) (Lent et al., 2002), and one of two variables utilized to measure career aspirations among students within Union County Magnet High School. According to SCCT, goals are prioritized according to an individual's level of self-efficacy and the outcome they expect as a result of their efforts. Goals are also influenced by the contextual influences that are proximal to an individual's choices. These contextual influences surface as either supports or barriers that can affect a person's career actions through the pursuit or abandonment of a specific career path (Lent et al., 2002).

The engineering subsection of the STEM Career Interest Survey (Kier et al., 2014) included two questions intended to measure personal goals. These two questions were assessed for the degree of internal consistency reliability that they achieved when combined to form a composite scale. Internal consistency reliability was assessed using Cronbach's alpha, and the full sample of fall and spring responses was used. The two goals questions achieved an alpha of .583, which is substantially below the threshold of .70 for the lowest level of reliability acceptable in measures used for research purposes. Further, the two goals items correlated at only .428. Therefore, since Goals was one of the two key dependent variables, I was confronted with choosing one question to capture the meaning of having a goal. I selected question E3 (I plan to use engineering in my future career) as the measure for goals since it seemed to best convey the idea of committing oneself to achieving a future goal. By contrast, question E4 (I will work hard on activities as school that involve engineering) seemed to express more of a commitment to investing effort in an educational process rather than a commitment to achieving a future outcome. Within all subsequent references within chapter four and chapter five, the term "Goals" reflects question E3.

Interests. In social cognitive career theory, an individual's interests involve the degree to which they enjoy something, and surfaces when an individual feels efficacious in their ability to be successful at an activity and when they believe that their engagement will lead to a valued outcome (Lent et. al., 2015). Along with goals, interests have been regarded as an influential factor in an individuals' pursuit of STEM opportunities while in high school (Heilbronner, 2013).

The engineering subsection of the STEM Career Interest Survey (Kier et al., 2014) included two questions intended to measure interests. Similar to the process used for goals, the two interest questions were assessed for the degree of internal consistency reliability that they achieved when combined to form a composite scale. Internal consistency reliability was again assessed using Cronbach's alpha, and the full sample of fall and spring responses was used. The two interest questions, E7 (I am interested in careers that involve engineering) and E8 (I like activities that involve engineering), had a Cronbach's alpha of .861 and correlation of .765. As a result, a scale score was computed as the mean of the two interest questions. Within all subsequent references within chapter four and chapter five, the term "Interests" reflects a scale score for questions E7 and E8.

Outcome expectations. Outcome expectations are the result of a person's learning experiences and directly influence an individual's interests and goals. Outcome expectations refer to a person's personal beliefs about the imagined consequences that are associated with performing a particular behavior or set of behaviors. Social cognitive career theory states that a person will be more likely to engage in an activity if they expect that it will lead to a positive outcome (Lent et al., 2002).

The engineering subsection of the STEM Career Interest Survey (Kier et al., 2014) included two questions intended to measure outcome expectations. Similar to the process used for goals and interests, the two outcome expectations questions were assessed for the degree of internal consistency reliability that they achieved when combined to form a composite scale. Internal consistency reliability was again assessed using Cronbach's alpha, and the full sample of fall and spring responses was used. The two outcome expectations questions, E5 (If I learn a lot about engineering, I will be able to do lots of different types of careers) and question E6 (My parents would like it if a choose an engineering career), had a Cronbach's alpha of .465 and correlation of .306. Within all subsequent references within chapter four and chapter five, the term "Career Choices" refers to question E5 and "Parental Approval" refers to question E6.

Self-efficacy. Self-efficacy is regarded as the most influential variable in social cognitive theory (Bandura, 1986). It is described as the extent to which an individual believes he or she can accomplish something and tends to increase with positive experiences, decrease with negative experiences, and exerts a central influence on outcome expectations, career interest, and goals (Lent et al., 2002).

The engineering subsection of the STEM Career Interest Survey (Kier et al., 2014) included two questions intended to measure self-efficacy. Similar to the process used for goals, interests, and outcome expectations, the two self-efficacy questions were assessed for the degree of internal consistency reliability that they achieved when combined to form a composite scale. Internal consistency reliability was again assessed using Cronbach's alpha, and the full sample of fall and spring responses was used. The two self-efficacy questions, E1 (I am able to do well in activities that involve engineering) and question E2 (I am able to complete activities that involve engineering) had a Cronbach's alpha of .812 and a correlation of .683. A scale score was used to represent self-efficacy variable. Within all subsequent references within chapter four and chapter five, the term "Self-Efficacy" reflects a scale score for questions E1 and E2.

Background contextual affordances. Background contextual affordances affect a person's career interests and goals through self-efficacy and outcome expectations. Contextual influences include things like socio-economic status, opportunities for development, and access to role models in either academic or career settings. These background contextual affordances contribute to an individual's opportunity structure that has the ability to either foster or hinder the development of career interests and goals (Lent et al., 2002).

The engineering subsection of the STEM Career Interest Survey (Kier et al., 2014) included two questions intended to measure background contextual affordances. These two questions were assessed for the degree of internal consistency reliability that they achieved when combined to form a composite scale. Internal consistency reliability was again assessed using Cronbach's alpha, and the full sample of fall and spring responses was used. The two background contextual affordances questions, E9 (I have a role model in an engineering career) and question E11 (I know of someone in my family who is an engineer) had a Cronbach's alpha of 0.679 and correlation of 0.522. Within all subsequent references within chapter four and chapter five, the term "Has a Role Model" refers to question E9 and "Family Connection" refers to question E11.

Personal inputs. Personal inputs include the social construct of gender. Within social cognitive career theory, gender socialization illustrates how a person's educational and career possibilities are influenced by how each gender is treated. As stated by Lent et al., (2002), a number of institutional barriers affect the self-efficacy levels of females, resulting in the development of higher levels of self-efficacy for domestic tasks and lower levels of self-efficacy for science. Moreover, females often prefer communal orientations. According to Clark and Mills (1993), those with communal orientations hold no expectation of repayment. Individuals with this type of orientation are attracted to careers that involve helping others or working with people (Diekman, Brown, Johnston, & Clark, 2010; Diekman, Clark, Johnston, Brown, and Steinberg, 2011; Tellhed, Bäckström, & Björklund, 2018). Females who tend to purse more communally oriented fields, such as teaching and the biological sciences, tend to disassociate themselves from mathematics-intensive STEM fields since these fields are in conflict with their preferred communal orientations.

The engineering subsection of the STEM Career Interest Survey (Kier et al., 2014) included several questions intended to measure personal inputs. First, gender was recorded as male, female, or prefers not to answer. Since this study measured gender differences, those who answered, “prefers not to answer” were excluded from the analysis. Secondly, personal inputs were measured using the student’s grade-level (e.g. 9-12) and semester (e.g. fall and spring). Finally, personal inputs were measured using race-ethnicity, however this variable was not included in the analysis since there was not enough variation in the sample.

4.2. Analysis

This quantitative research study included two primary research questions, each of which contained four hypotheses. First, this study set out to determine whether Union County Magnet High School students’ aspirations for an engineering career, as defined by interests and goals, differed by grade, gender, and semester (e.g. Fall vs. Spring). The second research question set out to determine the extent to which variables in social cognitive career theory explain UCMHS aspirations, and UCMHS gender-based differences in aspirations, for an engineering career. In doing so, interest in an engineering career was operationalized by a utilizing a two-item scale score for questions E7 and E8, while goals were operationalized through the use of question E3 (*I plan to use engineering in my future career*).

To answer the two research questions, this research study first calculated a set of descriptive statistics for goals (see Appendix B) and interests (see Appendix C). These statistics indicated that males had higher mean goal and interest scores than did females across all four grades and both semesters. To identify the paths through which gender produced differential levels of engineering-related interest and goals, separate multifactorial ANCOVAs assessing all main and 2-way interaction effects were conducted for goals, interests, outcome expectations, self-efficacy, and background contextual affordances, guided by the framework of the two research questions associated with this study. For each ANCOVA, the homogeneity of variance assumption was tested using the Levene's Test. In all cases, there were no problematic departures from homogeneity. The full results of the ANCOVAs with all interactions are included in the appendices (see Appendix D – M), while only the significant results are presented below for ease of reading, beginning with the two measures of career aspirations – goals and interests. The overall R-squared and adjusted R-squared values reported at the bottom of each ANCOVA table reflect the total proportion of variance in the dependent variable that was explained only by the effect sources that were statistically significant.

Goals 1.1. The first of three *goals* analyses was an ANCOVA with *goals* as the dependent variable, and *interests* and personal inputs (e.g. *gender, semester*, and *grade*) as the independent variables (see Figure 3). The descriptive statistics for *goals* by *gender* within *semester* and *grade* are presented in Table 5.1.

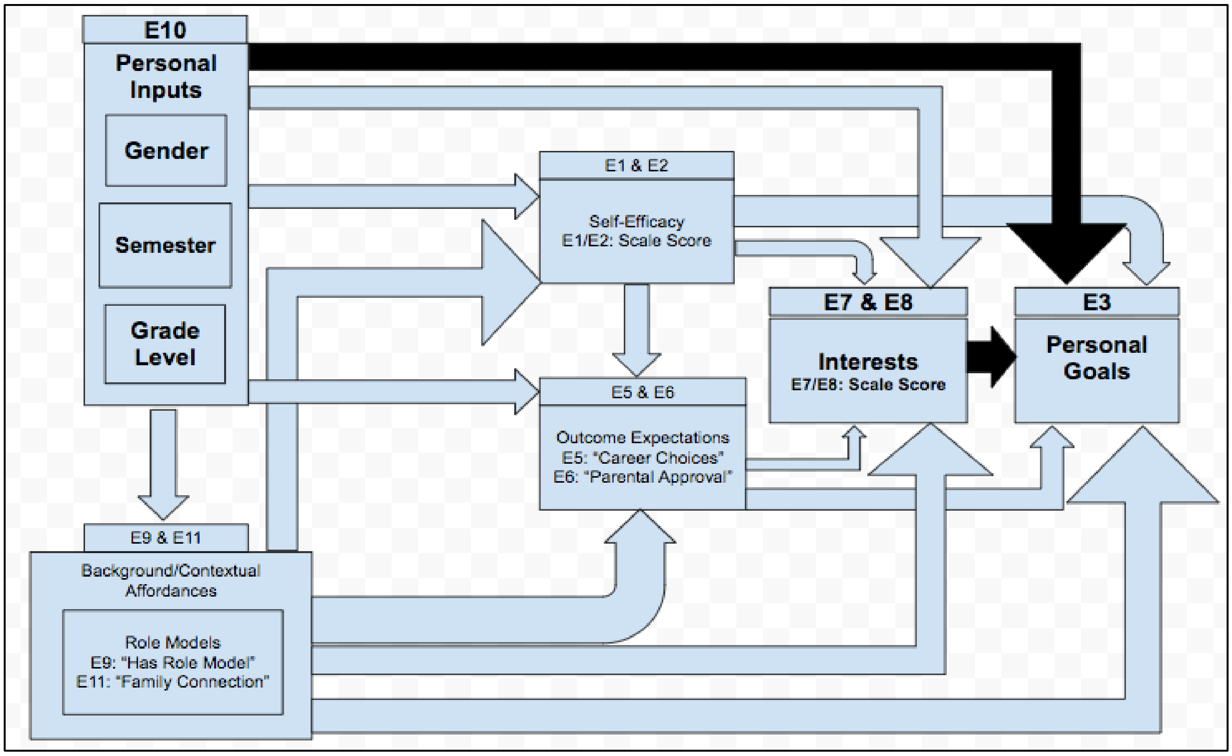

Figure 3. Linking theoretical model of SCCT. Dependent variable: Goals. Independent variables: Interests and Personal Inputs (adapted from Lent et al. 1994, 2000).

Table 5.1

Descriptive statistics for Goals by Gender within Grade and Semester

		Semester					
		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	3.81	1.116	47	3.39	1.146	44
	Female	3.48	1.475	25	3.36	1.524	25
10	Male	3.48	1.153	29	3.45	1.362	31
	Female	3.05	1.161	38	3.03	1.236	37
11	Male	3.73	1.098	33	3.48	1.253	33
	Female	3.48	1.122	27	3.11	1.219	27
12	Male	3.44	1.625	32	3.59	1.476	29
	Female	2.62	1.499	21	2.50	1.711	22

The findings of the ANCOVA of *goals* by *gender*, *semester*, and *grade* with *interest* (see Table 5.2) indicate that the main effect of *interest* ($p < .001$), *gender* ($p = .023$), and *grade* ($p =$

.002) were significant in predicting variance in *goals*. With respect to the two-way interactions, *gender* by *interests* (p = .037) and *grade* by *interests* (p = .017) were significant in predicting variance in *goals*. As indicated by the adjusted R-squared value, the significant factors in this model combined to explain 56.3% of the variance in *goals*.

Table 5.2

ANCOVA of Goals by Gender, Semester, and Grade with Interests: Main Effects and Significant Interactions

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Partial Eta^2	Eta^2
Gender	[Gender=0]	-.295	1	2.457	5.17	.023	.011	.002
	[Gender=1]	0[a]						
Semester	[Semester=1]	-.031	1	.11	.231	.631	.000	.000
	[Semester=2]	0[a]						
Grade	[Grade=9]	-.240	3	2.318	4.879	.002	.030	.007
	[Grade=10]	.298						
	[Grade=11]	.929						
	[Grade=12]	0[a]						
Interests	Interests	.973	1	585.815	1232.73	<.001	.719	.551
Gender * Interests	[Gender=0] * Interests	.115	1	2.082	4.381	.037	.009	.002
	[Gender=1] * Interests	0[a]						
Grade * Interests	[Grade=9] * Interests	.059	3	1.629	3.429	.017	.021	.005
	[Grade=10] * Interests	-.088						
	[Grade=11] * Interests	-.183						
	[Grade=12] * Interests	0[a]						
Error			481	0.475				

Note: Significant Effect R Squared = .567 (Adjusted Significant Effect R Squared = .563)

[a] reference category of categorical variable; no parameter estimate

Goals 1.2. The second of three *goals* analyses was an ANCOVA with *goals* as the dependent variable, along with *interests*, outcome expectations (e.g. *career choices* and *parental approval*), *self-efficacy*, and personal inputs (e.g. *gender, semester*, and *grade*) as the independent variables (see Figure 4).

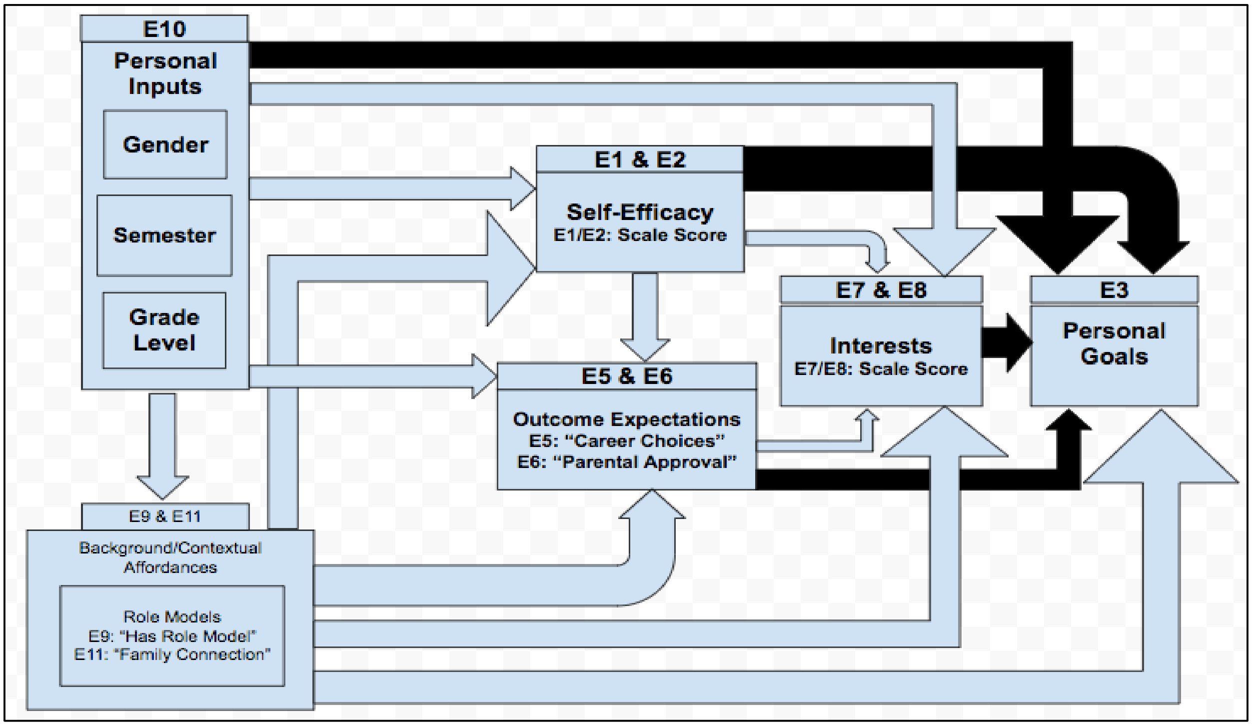

Figure 4. Linking theoretical model of SCCT. Dependent variable: Goals. Independent variables: Interests, *Career Choices*, *Parental Approval*, Self-Efficacy, background contextual affordances, and Personal Inputs (adapted from Lent et al. 1994, 2000).

The findings of the ANCOVA of *goals* by *gender*, *semester*, and *grade* with *interest*, *self-efficacy*, and outcome expectations (see Table 5.3) indicate that the main effect of *interest* ($p <$ .001) was significant in predicting variance in *goals*. There were no significant main effects or two-way interactions involving *gender*, but the two-way interactions of *grade* x *interest* ($p =$ .008) and of *career choices* x *parental approval* ($p =$ .002) were significant in predicting *goals*. As indicated by the Adjusted R-squared value, the significant factors in this model combined to explain 7.7% of the variance in *goals*, which represents a decrease over the previous *goals* model (56.3%).

Table 5.3

ANCOVA of Goals by Gender, Semester, and Grade with Interests, Self-Efficacy, and Outcome Expectations: Main Effects and Significant Interactions

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Partial Eta^2	Eta^2
Gender	[Gender=0]	-.277	1	.311	.68	.41	.001	.001
	[Gender=1]	0[a]						
Semester	[Semester=1]	.143	1	.310	.677	.411	.001	.001
	[Semester=2]	0[a]						
Grade	[Grade=9]	.289	3	.517	1.128	.337	.007	.006
	[Grade=10]	.886						
	[Grade=11]	.774						
	[Grade=12]	0[a]						
Interests	Interests	1.23	1	12.75	27.83	.000	.057	.051
Self-efficacy	Self-efficacy	.032	1	.077	.169	.681	.000	.000
Career Choices	Career Choices	-.246	1	1.355	2.958	.086	.006	.005
Parental Approval	Parental Approval	-.265	1	1.353	2.953	.086	.006	.005
Grade * Interests	[Grade=9] * Interests	.177	3	1.813	3.958	.008	.025	.022
	[Grade=10] * Interests	-.011						
	[Grade=11] * Interests	-.188						
	[Grade=12] * Interests	0[a]						
Career Choices * Parental Approval	Career Choices * Parental Approval	.106	1	4.357	9.511	.002	.020	.017
Error			479	0.458				

Note: Significant Effect R Squared = .090 (Adjusted Significant Effect R Squared = .077)

[a] reference category of categorical variable; no parameter estimate

Goals 1.3. The third of three *goals* analyses was an ANCOVA with *goals* as the dependent variable, and *interests*, outcome expectations (e.g. *career choices* and *parental approval*), *self-efficacy*, background contextual affordances (e.g. *has role model* and *family connection*), and personal inputs (e.g. *gender*, *semester*, and *grade*) as the independent variables (see Figure 5).

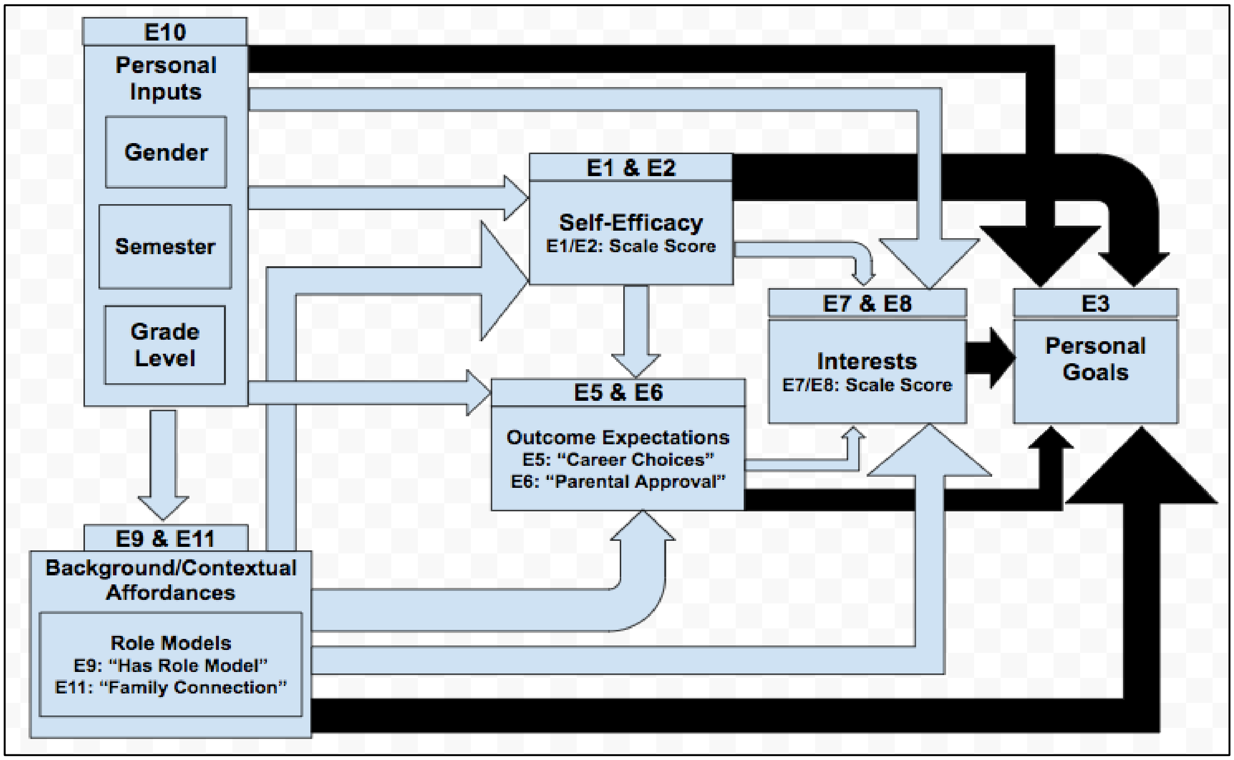

Figure 5. Linking theoretical model of SCCT. Dependent variable: Goals. Independent variables: Interests, *Career Choices*, *Parental Approval*, Self-Efficacy, *Has Role Model*, *Family Connection*, and Personal Inputs (adapted from Lent et al. 1994, 2000).

The findings of the ANCOVA of *goals* by *gender*, *semester*, and *grade* with *interest*, *self-efficacy*, outcome expectations, and background contextual affordances (see Table 5.4) indicate that the main effects of *interest* ($p < .001$), as well as the two-way interactions of *grade* x *interest* ($p = .031$) and of *career choices* x *parental approval* ($p = .011$), explained significant amounts of variance in *goals*. However, neither *gender* nor any of the two-way interactions with *gender* were significant in predicting variance in *goals*. As indicated by the adjusted R-squared value, the significant factors in this model combined to explain 4.9% of the variance in *goals*, which represents a decrease over the previous two *goals* models (7.7% and 56.3%).

Table 5.4

ANCOVA of Goals by Gender, Semester, and Grade with Interests, Self-Efficacy, Outcome Expectations, and Background Contextual Affordances: Main Effects and Significant Interactions

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Partial Eta^2	Eta^2
Gender	[Gender=0]	-.406	1	.388	.859	.355	.002	.002
	[Gender=1]	0[a]						
Semester	[Semester=1]	.212	1	.412	.911	.340	.002	.002
	[Semester=2]	0[a]						
Grade	[Grade=9]	.478	3	.582	1.288	.278	.009	.007
	[Grade=10]	.940						
	[Grade=11]	.912						
	[Grade=12]	0[a]						
Interests	Interests	1.11	1	8.873	19.625	.000	.043	.037
Self-efficacy	Self-efficacy	.157	1	.001	.002	.968	.000	.000
Career Choices	Career Choices	-.218	1	1.058	2.341	.127	.005	.004
Parental Approval	Parental Approval	-.263	1	1.502	3.323	.069	.008	.006
Has Role Model	Has Role Model	.174	1	.485	1.072	.301	.002	.002
Family Connection	Family Connection	-.157	1	.204	.452	.502	.001	.001
Grade * Interests	[Grade=9] * Interests	.158	3	1.350	2.986	.031	.020	.017
	[Grade=10] * Interests	.021						
	[Grade=11] * Interests	-.168						
	[Grade=12] * Interests	0[a]						
Career Choices * Parental Approval	Career Choices * Parental Approval	.093	1	2.984	6.600	.011	.015	.012
Error			436	.452				

Note: Significant Effect R Squared = .067 (Adjusted Significant Effect R Squared = .049)

[a] reference category of categorical variable; no parameter estimate

Interests 1.1. The first of two interest analyses was an ANCOVA with interests as the dependent variable, along with outcome expectations (e.g. *career choices* and *parental approval*), *self-efficacy*, and personal inputs (e.g. *gender*, *semester*, and *grade*) as the independent variables (see Figure 6). The descriptive statistics for *interest* by *gender* within *semester* and *grade* are presented in Table 6.1.

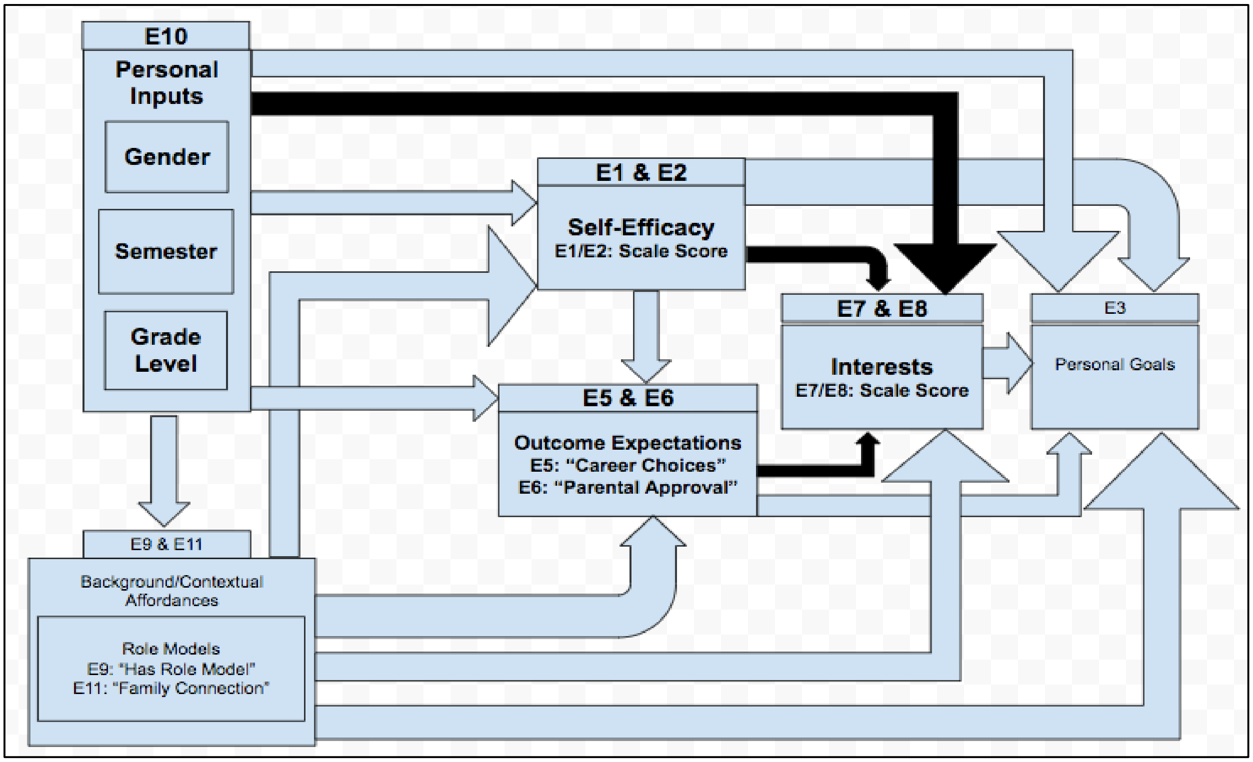

Figure 6. Linking theoretical model of SCCT. Dependent variable: Interests. Independent variables: *Career Choices*, *Parental Approval*, *Self-Efficacy*, and Personal Inputs (adapted from Lent et al. 1994, 2000).

Table 6.1

Descriptive statistics for Interests by Gender within Grade and Semester

		Semester					
		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	3.85	0.983	47	3.69	0.864	44
	Female	3.64	1.186	25	3.52	1.15	25
10	Male	3.74	1.006	29	3.61	1.108	31
	Female	3.21	1.113	38	3.26	1.158	37
11	Male	3.88	0.91	33	3.65	1.196	33
	Female	3.17	1.217	27	2.96	1.117	27
12	Male	3.72	1.231	32	3.66	1.203	29
	Female	2.86	1.534	21	2.75	1.594	22

The results of the ANCOVA of *interest* by *gender*, *semester*, and *grade* with *self-efficacy* and outcome expectations (see Table 6.2) indicate that the main effect of *grade* (p = .019), as well as the two-way interactions of *grade* by *parental approval* (p = .039) and of *grade* by *self-efficacy* (p = .002) explained significant amounts of variance in *interest*. However, neither *gender* nor any of the two-way interactions involving *gender* explained significant amounts of variance in *interest*. As indicated by the adjusted R-squared value, the significant factors in this model combined to explain 5.1% of the variance in *interest*.

Table 6.2

ANCOVA of Interests by Gender, Semester, and Grade with Self-Efficacy and Outcome Expectations: Main Effects and Significant Interactions

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Partial Eta^2	Eta^2
Gender	[Gender=0]	-.053	1	.021	.03	.862	.000	.000
	[Gender=1]	0[a]						
Semester	[Semester=1]	.017	1	.384	.566	.452	.001	.001
	[Semester=2]	0[a]						
Grade	[Grade=9]	1.53	3	2.267	3.338	.019	.021	.019
	[Grade=10]	.148						
	[Grade=11]	1.66 2						
	[Grade=12]	0[a]						
Self-efficacy	Self-efficacy	.411	1	.243	.357	.550	.001	.001
Career Choices	Career Choices	.176	1	1.237	1.822	.178	.004	.003
Parental Approval	Parental Approval	.046	1	.011	.017	.897	.000	.000
Grade * Parental Approval	[Grade=9] * Parental App.	-.117	3	1.907	2.809	.039	.018	.016
	[Grade=10] * Parental App.	.107						
	[Grade=11] * Parental App.	-.143						
	[Grade=12] * Parental App.	0[a]						
Grade * Self-Efficacy	[Grade=9] * Self-Efficacy	-.428	3	3.336	4.913	.002	.031	.028
	[Grade=10] * Self-Efficacy	-.058						
	[Grade=11] * Self-Efficacy	-.503						
	[Grade=12] * Self-Efficacy	0[a]						
Error			466	0.679				

Note: Significant Effect R Squared = .062 (Adjusted Significant Effect R Squared = .051)

[a] reference category of categorical variable; no parameter estimate

Interests 1.2. The second of two analyses of *interest* was an ANCOVA with *interest* as the dependent variable, along with outcome expectations (e.g. *career choices* and *parental approval*), *self-efficacy*, background contextual affordances (e.g. *has role model* and *family connection*), and personal inputs (e.g. *gender*, *semester*, and *grade*) as the independent variables (see Figure 7).

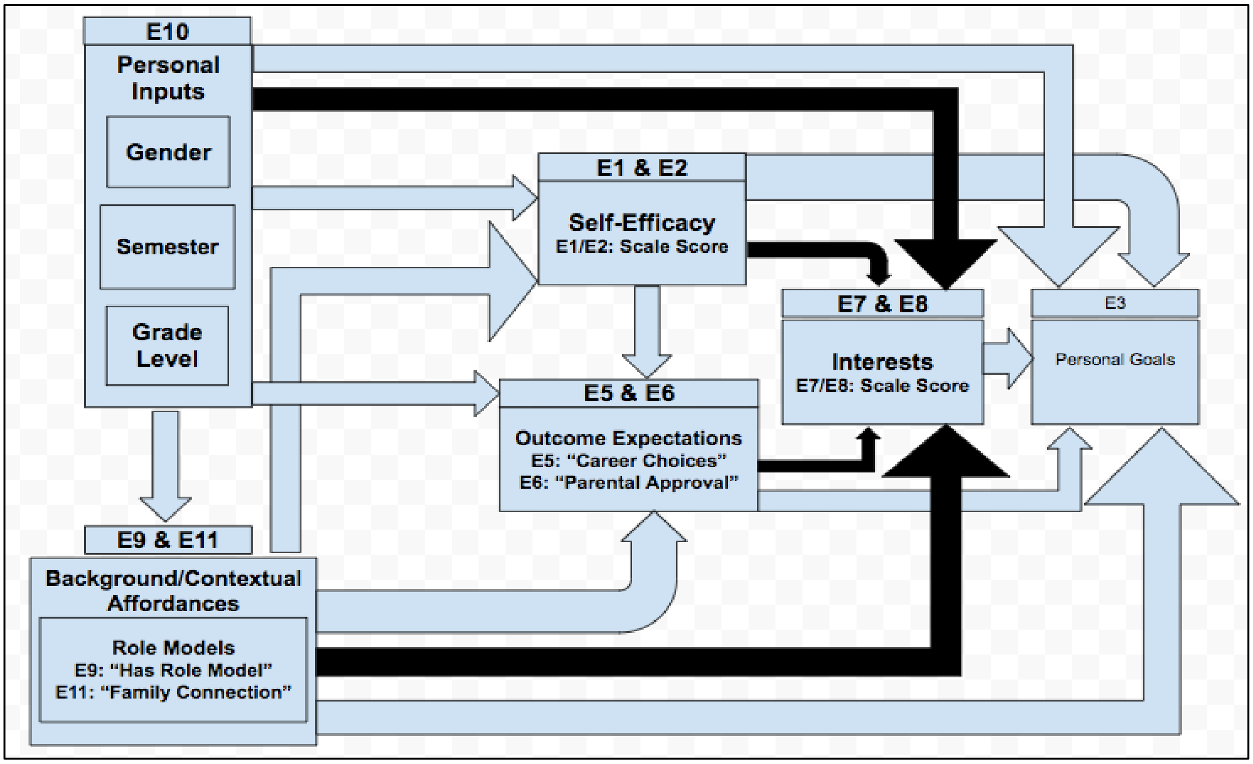

Figure 7. Linking theoretical model of SCCT. Dependent variable: Interests. Independent variables: *Career Choices*, *Parental Approval*, *Self-Efficacy*, *Has Role Model*, *Family Connections*, and Personal Inputs (adapted from Lent et al. 1994, 2000).

The findings of the ANCOVA of *interest* by *gender*, *semester*, and *grade* with *self-efficacy*, outcome expectations, and background contextual affordances (see Table 6.3) indicate that there were three significant main effects, including *grade* (p = .01), *has role model* (p = .001), and *family connection* (p = .017). There were also two two-way interactions that explained significant amounts of variance in *interest*, including *grade* by *self-efficacy* (p = .002) and *has role model* by *family connection* (p = .005). However, neither *gender* nor any of the two-way interactions involving *gender*, explained significant amounts of variance in *interest*. As indicated by the adjusted R-squared value, the significant factors in this model combined to explain 8.1% of the variance in *interest*, which represents an increase over the previous *interest* model (5.1%).

Table 6.3

ANCOVA of Interests by Gender, Semester, and Grade with Self-Efficacy, Outcome Expectations, and Background Contextual Affordances: Main Effects and Significant Interactions

Source	Parameter Estimates							
	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta²	Eta²
Gender	Gender=0	-.068	1	.003	.005	.946	.000	.000
	Gender=1	0[a]						
Semester	Semester=1	.11	1	.435	.667	.415	.001	.001
	Semester=2	0[a]						
Grade	Grade=9	1.97	3	2.486	3.809	.010	.025	.021
	Grade=10	.621						
	Grade=11	1.876						
	Grade=12	0[a]						
Self-efficacy	Self-efficacy	.425	1	.227	.347	.556	.001	.001
Career choices	Career choices	.110	1	.645	.988	.321	.002	.002
Parental approval	Parental approval	-.056	1	.056	.086	.769	.000	.000
Has role model	Has role model	.758	1	7.979	12.226	.001	.027	.022
Family connection	Family connection	-.347	1	3.744	5.737	.017	.013	.010
Grade * Self-efficacy	Grade=9 * Self-efficacy	-.457	3	3.267	5.006	.002	.033	.027
	Grade=10 * Self-efficacy	-.062						
	Grade=11 * Self-efficacy	-.498						
	Grade=12 * Self-efficacy	0[a]						
Has role model * Family connection	Has role model * Family connection	-.052	1	5.208	7.981	.005	.018	.015
Error			447	.653				

Note: Significant Effect R Squared = .096 (Adjusted Significant Effect R Squared = .081)
[a] reference category of categorical variable; no parameter estimate

Outcome expectations. There were two ANCOVA analyses conducted for outcome expectations. The first was an ANCOVA with *career choices* as the dependent variable and *self-efficacy*, background contextual affordances (e.g. *has role model* and *family connection*), and personal inputs (e.g. *gender*, *semester*, and *grade*) as the independent variables. The second was an ANCOVA with *parental approval* as the dependent variable and *self-efficacy*, background contextual affordances (e.g. *has role model* and *family connection*), and personal inputs (e.g.

gender, *semester*, and *grade*) as the independent variables (see Figure 8). The descriptive statistics for outcome expectations by *gender* within *semester* and *grade* are presented in Tables 7.1 and 7.2.

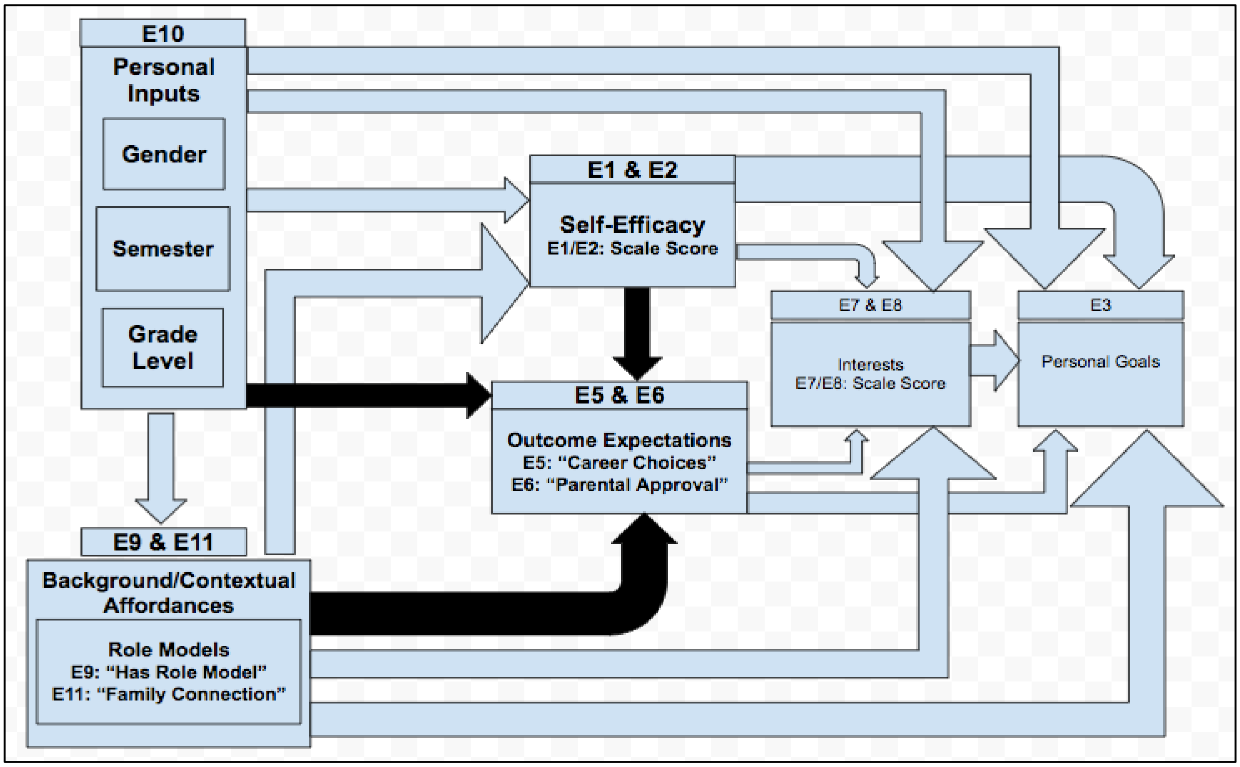

Figure 8. Linking theoretical model of SCCT. Dependent variables: *career choices* and *parental approval*; Independent variables: *self-efficacy*, *has role model*, *family connections*, and personal inputs (*gender, semester, and grade*; adapted from Lent et al. 1994, 2000).

Table 7.1

Descriptive statistics for Outcome Expectations: Career Choices by Gender within Grade and Semester

		Semester					
		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	4.04	.932	47	3.82	1.018	44
	Female	4.36	.700	25	4.00	1.041	25
10	Male	4.24	.786	29	3.74	.965	31
	Female	3.82	1.010	38	3.73	1.018	37
11	Male	4.18	.769	33	3.97	.918	33
	Female	3.93	.997	27	3.89	1.121	27
12	Male	3.97	1.062	32	3.86	1.060	29
	Female	3.90	1.300	21	3.36	1.136	22

Table 7.2

Descriptive statistics for Outcome Expectations: Parental Approval by Gender within Grade and Semester

		Semester					
		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	3.55	1.138	47	3.55	1.150	44
	Female	3.84	.987	25	3.28	1.370	25
10	Male	3.48	1.243	29	3.52	1.061	31
	Female	3.42	1.056	38	3.65	1.086	37
11	Male	3.61	.998	33	3.58	1.173	33
	Female	3.63	1.214	27	3.26	1.259	27
12	Male	3.59	1.103	32	3.41	1.323	29
	Female	3.38	1.396	21	3.23	1.307	22

The findings of the *career choices* by *gender*, *semester*, *and grade* with *self-efficacy* and background contextual affordances ANCOVA (see Table 7.3) indicate that the main effects of *grade* ($p < .001$) and *self-efficacy* ($p < .001$) explained significant amounts of variance in outcome expectations, as defined by *career choices*. The main effect of *gender* was not significant in explaining variance in outcome expectations, as defined by *career choices*, but the interaction of *gender* by *has role model* was significant (p = .01), as was *grade* by *self-efficacy* (p < .001). As indicated by the adjusted R-squared value, the significant factors in this model combined to explain 11.6% of the variance in *career choices*.

Table 7.3

ANCOVA of Outcome Expectations (Career Choices) by Gender, Semester, and Grade with Self-Efficacy and Background Contextual Affordances: Main Effects and Significant Interactions

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Partial Eta^2	Eta^2
Gender	[Gender=0]	.412	1	1.066	1.298	.255	.003	.002
	[Gender=1]	0[a]						
Semester	[Semester=1]	.469	1	1.202	1.463	.227	.003	.003
	[Semester=2]	0[a]						
Grade	[Grade=9]	3.01	3	6.854	8.344	<.001	.051	.045
	[Grade=10]	1.03						
	[Grade=11]	.779						
	[Grade=12]	0[a]						
Self-efficacy	Self-efficacy	.831	1	11.355	13.824	<.001	.029	.025
Has Role Model	Has Role Model	.191	1	.828	1.008	.316	.002	.002
Family Connection	Family Connection	.186	1	.935	1.138	.287	.002	.002
Gender * Has Role Model	Gender=0 * Has Role Model	.009	1	5.43	6.611	.010	.014	.012
	Gender=1 * Has Role Model	.191						
Grade * Self-Efficacy	[Grade=9] * Self-Efficacy	-.683	3	6.16	7.5	<.001	.046	.040
	[Grade=10] * Self-Efficacy	-.287						
	[Grade=11] * Self-Efficacy	-.169						
	[Grade=12] * Self-Efficacy	0[a]						
Error			466	.821				

Note: Significant Effect R Squared = .121 (Adjusted Significant Effect R Squared = .116)

[a] reference category of categorical variable; no parameter estimate

The findings of the ANCOVA of *parental approval* by *gender*, *semester*, and *grade* with *self-efficacy* and background contextual affordances (see Table 7.4) indicate that there were no significant main or two-way effects that explained significant amounts of variance in outcome expectations, as defined by *parental approval*. As indicated by the adjusted R-squared value, the nonsignificant factors in this model combined to explain 0% of the variance in *parental approval*, which is lower than the *career choices* model (11.6%).

Table 7.4

ANCOVA of Outcome Expectations (Parental Approval) by Gender, Semester, and Grade with Self-Efficacy and Background Contextual Affordances: Main Effects and Significant Interactions

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	-.098	1	.179	.142	.707	.000	.000
	Gender=1	0[a]						
Semester	Semester=1	-.065	1	.106	.084	.773	.000	.000
	Semester=2	0[a]						
Grade	Grade=9	1.011	3	1.345	1.06	.364	.007	.006
	Grade=10	1.577						
	Grade=11	.654						
	Grade=12	0[a]						
Self-efficacy	Self-efficacy	.138	1	.148	.117	.733	.000	.000
Has role model	Has role model	.446	1	3.450	2.726	.099	.006	.006
Family connection	Family connection	-.315	1	2.924	2.311	.129	.005	.005
No significant Interaction effects								
Error			466	1.265				

Note: Significant Effect R Squared = 0.0 (Adjusted Significant Effect R Squared = 0.0)
[a] reference category of categorical variable; no parameter estimate

Self-efficacy. Self-efficacy was used as the dependent variable in an ANCOVA specifying background contextual affordances (e.g. *has role model* and *family connection*), and personal inputs (e.g. *gender, semester,* and *grade*) as the independent variables (see Figure 9). The descriptive statistics for outcome expectations by gender within *semester* and *grade* are presented in Table 8.1.

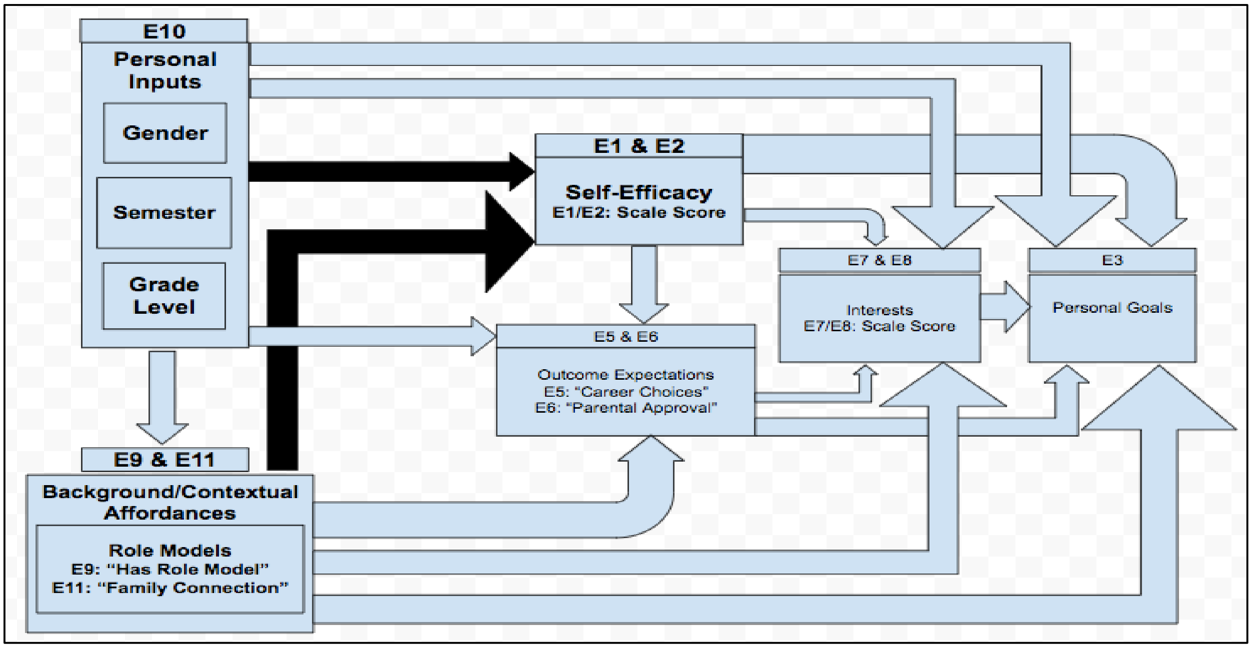

Figure 9. Linking theoretical model of SCCT. Dependent variable: Self-Efficacy. Independent variables: *has role model*, *family connections*, and Personal Inputs (adapted from Lent et al. 1994, 2000).

Table 8.1

Descriptive statistics for Self-efficacy by Gender within Grade and Semester

		Semester					
		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	3.87	.769	47	4.24	.727	44
	Female	3.80	.777	25	3.96	.989	25
10	Male	4.03	.516	29	4.26	.575	31
	Female	4.04	.841	38	3.95	.864	37
11	Male	4.29	.545	33	4.33	.608	33
	Female	4.07	.583	27	4.06	.543	27
12	Male	4.27	.842	32	4.24	.763	29
	Female	3.74	1.147	21	3.48	1.063	22

The findings of the *self-efficacy* by *gender*, *semester*, and *grade* with background contextual affordances ANCOVA (see Table 8.2) indicate no significant main effect of *gender, semester*, or *grade* on *self-efficacy*. However, the main effects of *has role model* ($p < .001$) and *family connection* (*p* = .002) were significant in predicting variance in self-efficacy. The two-way interactions of gender by grade (*p* = .021) and *has role model* by *family connection* (*p* = .004) also explained significant amounts of variance in *self-efficacy*. As indicated by the adjusted R-squared value, the significant factors in this model combined to explain 7.1% of the variance in *self-efficacy*.

Table 8.2

ANCOVA of Self-Efficacy by Gender, Semester, and Grade with Background Contextual Affordances: Main Effects and Significant Interactions

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	0[a]	1	.843	1.51	.220	.003	.003
	Gender=1	.023						
Semester	Semester=1	-.009	1	.351	.63	.428	.001	.001
	Semester=2	.002						
Grade	Grade=9	0[a]	3	1.13	2.024	.110	.013	.011
	Grade=10	.067						
	Grade=11	-.007						
	Grade=12	-.010						
Has role model	Has role model	.216	1	8.364	14.985	<.001	.031	.028
Family connection	Family connection	.120	1	5.564	9.969	.002	.021	.019
Gender * Grade	Gender=0 * Grade=9	0[a]	3	1.822	3.264	.021	.020	.018
	Gender=0 * Grade=10	-.505						
	Gender=0 * Grade=11	-.234						
	Gender=0 * Grade=12	-.151						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Has role model * Family connection	Has role model * Family connection	-.046	1	4.713	8.443	.004	.018	.016
Error			474	.558				

Note: Significant Effect R Squared = .080 (Adjusted Significant Effect R Squared = .071)
[a] reference category of categorical variable; no parameter estimate

Background contextual affordances. There were two ANCOVAs conducted for background contextual affordances. The first was an ANCOVA with *has role model* as the dependent variable, along with personal inputs (e.g. *gender, semester, and grade*) as the independent variables. The second was an ANCOVA with *family connection* as the dependent variable, along with personal inputs (e.g. *gender, semester, and grade*) as the independent variables (see Figure 10).

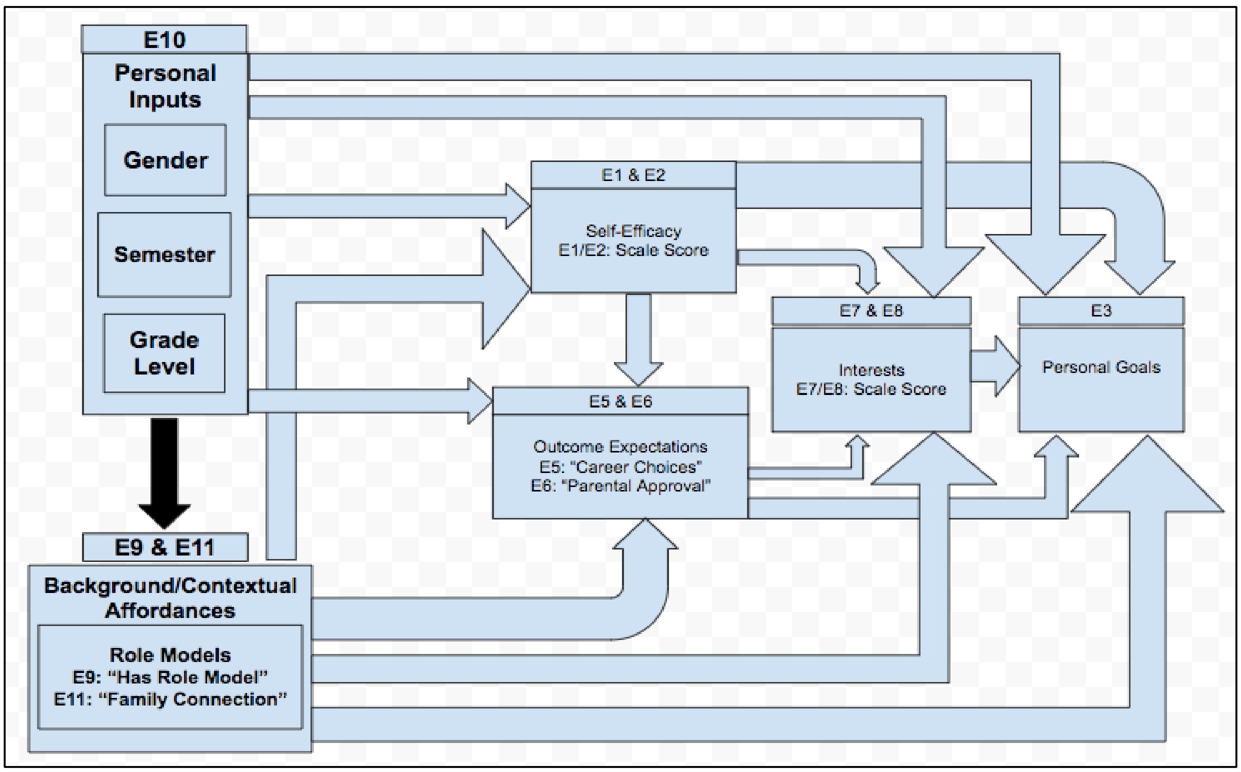

Figure 10. Linking theoretical model of SCCT. Dependent variables: *has role model* and *family connections*. Independent variables: Personal Inputs (adapted from Lent et al. 1994, 2000).

Table 9.1

Descriptive statistics for Background Contextual Affordances: Has Role Model by Gender within Grade and Semester

		Semester					
		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	2.85	1.383	47	2.43	1.421	44
	Female	2.92	1.412	25	2.64	1.800	25
10	Male	2.45	1.429	29	2.81	1.493	31
	Female	2.45	1.483	38	2.14	1.357	37
11	Male	2.88	1.516	33	3.24	1.501	33
	Female	2.59	1.394	27	2.44	1.396	27
12	Male	2.34	1.638	32	2.55	1.378	29
	Female	2.95	1.627	21	3.23	1.572	22

Table 9.2

Descriptive statistics for Background Contextual Affordances: Family Connection by Gender within Grade and Semester

		Semester					
		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	3.00	1.719	47	2.93	1.704	44
	Female	3.32	1.773	25	3.28	1.904	25
10	Male	3.24	1.845	29	3.26	1.712	31
	Female	3.08	1.822	38	3.11	1.912	37
11	Male	3.61	1.619	33	3.36	1.674	33
	Female	2.67	1.776	27	3.07	1.730	27
12	Male	2.75	1.934	32	2.83	1.814	29
	Female	4.14	1.459	21	3.50	1.711	22

The findings of the *has role model* by *gender, semester, and grade* ANCOVA (see Table 9.3) indicate no significant main effect of *gender, semester, or grade* on background contextual affordances, as defined by *has role model*. However, *gender* by *grade* (p = .015) was significant in predicting variance in background contextual affordances, as defined by *has role model*. As indicated by the adjusted R-squared value, the significant factors in this model combined to explain 1.1% of the variance in *has role model*.

Table 9.3

ANCOVA of Background Contextual Affordances (Has Role Model) by Gender, Semester, and Grade: Main Effects and Significant Interactions

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	-.511	1	.08	.037	.848	.000	.000
	Gender=1	0[a]						
Semester	Semester=1	-.083	1	.042	.019	.89	.000	.000
	Semester=2	0[a]						
Grade	Grade=9	-.622	3	2.911	1.332	.263	.008	.008
	Grade=10	-.906						
	Grade=11	-.620						
	Grade=12	0[a]						
Gender * Grade	Gender=0 * Grade=9	.505	3	7.703	3.526	.015	.021	.021
	Gender=0 * Grade=10	.980						
	Gender=0 * Grade=11	1.183						
	Gender=0 * Grade=12	0[a]						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Error			487	2.185				

Note: Significant Effect R Squared = .021 (Adjusted Significant Effect R Squared = .011)
[a] reference category of categorical variable; no parameter estimate

The findings of the *family connection* by *gender, semester, and grade* ANCOVA (see Table 9.4) indicate no significant main effect of *gender, semester, or grade* on background contextual affordances, as defined by *family connection*. However, *gender* by *grade* (p = .004) was significant in predicting variance in background contextual affordances, as defined by *family connection*. As indicated by the adjusted R-squared value, the significant factors in this model combined to explain 1.7% of the variance in *family connection*, which is higher than the *has role model* (1.1%).

Table 9.4

ANCOVA of Background Contextual Affordances (Family Connection) by Gender, Semester, and Grade: Main Effects and Significant Interactions

Source	Parameter Estimates: Parameter	B	df	Mean Square	F	p	Partial Eta^2	Eta^2
Gender	[Gender=0]	3.71	1	2.665	.858	.355	.002	.002
	[Gender=1]	-1.05						
Semester	[Semester=1]	0[a]	1	.306	.098	.754	.000	.000
	[Semester=2]	.209						
Grade	[Grade=9]	0[a]	3	.559	.18	.910	.001	.001
	[Grade=10]	-.435						
	[Grade=11]	-.602						
	[Grade=12]	-.811						
Gender * Grade	Gender=0 * Grade=9	0[a]	3	13.709	4.413	.004	.026	.026
	Gender=0 * Grade=10	.701						
	Gender=0 * Grade=11	1.19						
	Gender=0 * Grade=12	1.65						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Error			487	3.106				

Note: Significant Effect R Squared = .026 (Adjusted Significant Effect R Squared = .017)

[a] reference category of categorical variable; no parameter estimate

Chapter 5: Conclusions, Discussion, and Suggestions for Future Research

This chapter presents a summary of the analytical results, draws conclusions that are related to the extant literature and theoretical framework that guided this study from the onset, identifies key areas that potentially limit the generalizability of these findings, acknowledges implications for practice within the Union County Magnet High School community, and provides guidance on several next steps that might further the area of inquiry concerning the dearth of females in mathematics-intensive STEM fields among high school students.

5.1. Summary of Analytic Results

The findings for this quantitative research study are summarily categorized according to two primary research questions that were set forth to quantitatively investigate the career aspirations of students enrolled in a specialized engineering-based career academy vocational high school. Both research questions were constructed according to the variables found within social cognitive career theory, and subsequently answered through an analysis of students' responses to fourteen STEM career interest survey questions, given in fall 2017 and spring 2018.

Research question 1. The first research question investigated how aspirations for an engineering career, as defined by interest and goals, differ by gender, grade level, and from fall to spring for students within Union County Magnet High School. This research question was answered by four hypotheses, each specifying a different combination of gender, grade, and semester. Interest was operationalized by a scale score of the two interest questions, which included E7 (*I am interested in careers that involve engineering*) and E8 (*I like activities that involve engineering*). Goals were operationalized through the use of question E3 (*I plan to use engineering in my future career*).

Hypothesis 1a. This hypothesis stated that Union County Magnet High School student aspirations for a career in engineering, as defined by interest and goals, would differ by gender. Although males had nominally higher mean scores on both *interest* and *goal* scores (see Appendix B) in each of the four grades and in each semester, the *p*-values for *gender* and its interactions with any of the other variables in this study failed to reach significance in explaining variance in *interest*. For goals, the *p*-value for the main effect of *gender*, as well as that for its interaction with *interest*, reached significance when the model included only *interest*, *gender*, *semester*, and *grade* (see Table 5.2). When outcome expectations and *self-efficacy* (see Table 5.3), and background contextual affordances (see Table 5.4) were added to the model, the *p*-values of both effects involving *gender* weakened to the point of nonsignificance. Among these latter groups of variables in the presence of which the effect of *gender* in explaining *goals* variance was suppressed, *self-efficacy* emerged as the only strong candidate for the source of this suppression. It was the only one of these variables on which a strongly significant gender difference (favoring males) occurred (see Appendix N). It appears likely that the effect of *gender* on *goals* is largely expressed as a gender difference in *self-efficacy* in reference to the prospect of working as an engineer. *Self-efficacy* is also moderately correlated with *interest*, accounting for over 23% of its variance. The inclusion of *self-efficacy* in the model consequently diminishes the main effects of both *gender* and *interest*, and of their interaction on goals.

***Hypothesis 1b*.** The second hypothesis for this first research question stated that Union County Magnet High School student aspirations for a career in engineering, as defined by interest and goals, would be higher in the spring than in the fall. This hypothesis was tested by examining the results for the *semester* factor in the ANCOVAs of *goals* (see Tables 5.2-5.4) and of *interest* (see Tables 6.2 and 6.3). This examination revealed that neither the main effect of the *semester* factor, nor any of its two-way interactions with other factors, explained significant amounts of variance in either *goals* or *interest*. Consequently, the null hypothesis was not rejected. This study found no evidence to support the existence of differences in interest and goals between the two semesters.

Hypothesis 1c. The third hypothesis for this first research question stated that gender differences in aspirations for a career in engineering, as defined by interest and goals, would be lower in the spring than in the fall among Union County Magnet High School students. In examining the *semester* by *gender* interaction for *goals* (see Tables 5.2-5.4) and *interest* (see Tables 6.2 and 6.3), this study found *no* evidence to justify the rejection of the third null hypothesis. Gender differences on *goals* and *interest* did not change significantly between semesters on either aspect of aspirations for a career in engineering.

Hypothesis 1d. The fourth hypothesis for this first research question stated that Union County Magnet High School student aspirations for a career in engineering, as defined by interest and goals, would differ by grade level. The findings revealed that the *grade* main effect and the *grade* by *interest* interaction each explained significant portions of variance in *goals* (see Table 5.2) when including *interest*, *gender*, *semester*, and *grade*. The significant *grade* by *interest* interaction indicates that the influence of interest on goals differs between grade levels. The lowest *interest* – *goals* correlation occurred among 11^{th} grade students ($r = .793$) and the highest occurred among 12^{th} grade students ($r = .894$; see Appendix O). When outcome expectations and *self-efficacy* (see Table 5.3), as well as background contextual affordances (see Table 5.4), were added to the model, the *grade* by *interest* interaction remained significant despite the weakening of the *grade* main effect to nonsignificance.

For interests, there were significant main effects for *grade, has role model,* and *family connection* on *interest* when the model included outcome expectations, *self-efficacy*, *gender*, *semester*, *grade* and background contextual affordances (see Tables 6.2 and 6.3). In addition, the two-way interactions between *grade* and *parental approval*, between *grade* and *self-efficacy,* and between *has role model* and *family connection* (see Tables 6.2 and 6.3) explained significant amounts of variance in interests. These significant main and interaction effects explained 8.1% (adjusted) of the variance in interests.

Research question 2. The second research question sought to determine the extent to which the variables identified in social cognitive career theory's operational model explain aspirations for an engineering career, as well as the differences in these aspirations by gender, for students within Union County Magnet High School.

Hypothesis 2a. The first hypothesis for this second research question stated that a subset of the variables of outcome expectations, *self-efficacy*, background contextual affordances, and personal inputs would account for variance in aspirations for a career in engineering, as defined by interest and goals. This study found evidence to reject the null hypothesis with respect to goals – the variance of the *goals* measure was explained to a significant degree by the main effect of *interest*, and by the two-way interactions between *grade* and *interest* and between *career choices* and *parental approval* (see Tables 5.3 and 5.4). The *interest* variable explained 5 to 100 times more variance in goals than any other variable in the model, even when all the other variables were included in the model. This finding supports the validity of the model's specification of interest as the most proximal source of influence on goals.

The null hypothesis with respect to interests was also rejected. The main effects of background contextual affordances (e.g. *family connection* and *has role model*) and *grade,* and the two-way interactions between *grade* and *self-efficacy*, and between *has role model* and *family connections*, explained significant amounts of variance in interests (see Table 6.3). The variance explained by all these significant effects added up to 8.1% (adjusted) of the total variance in *interest*, indicating that the major sources of variability in student interest in engineering lay beyond the purview of this model.

Hypothesis 2b. The second hypothesis for this second research question stated that gender differences among Union County Magnet High School students on one or more predictors (e.g. outcome expectations, self-efficacy, background contextual affordances, and personal inputs) would result in gender differences in aspirations for a career in engineering. The null of this hypothesis was not rejected because the main effect of gender, when all factors were included in the model, did not explain significant amounts of variance in goals (see Table 5.4) or in interest (see Table 6.3).

Hypothesis 2c. The third hypothesis for this second research question proposed that gender would moderate the relationships of outcome expectations, self-efficacy, background contextual affordances, and personal inputs with aspirations for a career in engineering. This study found no significant interactions with gender that explained significant variance in either *goals* or *interest*. As a result, no evidence was found to justify the rejection of the null hypothesis since variations in levels of outcome expectations, self-efficacy, background contextual affordances, and personal inputs were not associated with different levels of *goals* or *interests* for the two genders.

Hypothesis 2d. The fourth hypothesis for this second research question stated that the determinants of aspirations among Union County Magnet High School students would differ by grade-level. This study found evidence to reject the null of this hypothesis because in the case of each of the two aspects of aspirations, two-way interactions involving *grade* were found to explain significant amounts of variance. For *goals*, the significant interaction was found to be *grade* by *interest* (see Table 5.4); for *interest*, it was the *grade* by s*elf-efficacy* interaction that was found to be significant (see Table 6.3). From these findings it can be inferred that interest levels differ by grade and that these differences are associated with corresponding differences in goals. Further, it can be inferred that self-efficacy levels differ by grade and that these differences are associated with corresponding differences in interest levels.

5.2 Connections to Extant Literature

The extant research literature with respect to aspirations for mathematics intensive career paths, as defined by interests and goals, is largely consistent with the findings in this study. While there are a studies that conclude that interests are not an antecedent to goals (Lent et al., 2008), a majority of the extant literature provides evidence in support of interests affecting goals, including a number of high school studies (Heilbronner, 2013; Riegle-Crumb & Moore, 2013) and studies involving college engineering students (Hackett et al., 1992; Gainor & Lent, 1998; Inda et al., 2013; Sadler et al., 2012). These findings are consistent with this study's results, as the main effect of interests explained significant amounts of variance in goals, as did the interaction of *interests* by *grade,* among students at Union County Magnet High School (see Figure 11).

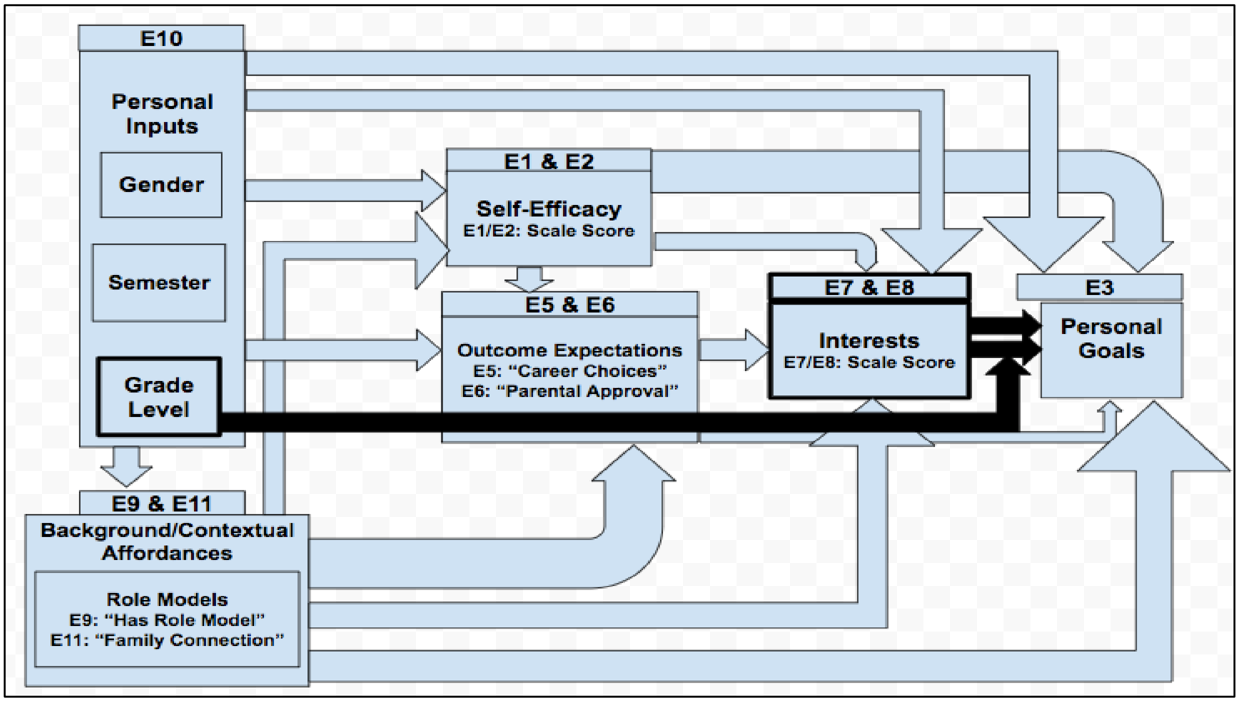

Figure 11. Linking theoretical model of SCCT with confirmed main effects and interactions. Dependent variable: *Goals*. Independent variables: Interest and Grade-Level (adapted from Lent et al. 1994, 2000).

A number of studies have also explored the contextual influences that are proximal to an individual's interests or goals, specifically outcome expectations (Gainor & Lent, 1998; Hackett et al., 1992; Inda et al., 2013; Lent et. al., 2001; Lent et al., 2003; Lent et. al., 2005; Lent et al., 2008) and self-efficacy (Gainor & Lent, 1998; Hackett et al., 1992; Inda et al., 2013; Lent et al., 1984; Lent et. al, 2005; Lent et. al., 2015). A number of studies found that outcome expectations explained significant amounts of variance in either interests (Gainor & Lent, 1998; Hackett et al., 1992; Inda et al., 2013; Lent et. al., 2001; Lent et. al., 2005) or in goals (Inda et al., 2013). However, the present study was more in line with Lent et al. (2003) and Lent et al. (2008), both of which found no evidence that outcome expectations explain significant amounts of variance in either goals (see Figure 11) or interest (see Figure 12). With respect to self-efficacy, the research literature is strong in its support for this construct explaining significant amounts of variance in interests (Gainor & Lent, 1998; Hackett et al., 1992; Inda et al., 2013; Lent et al., 1984; Lent et. al., 2005; Lent et. al., 2015) and goals (Lent et. al., 2005). However, much like outcome expectations, this present study yielded no such evidence that the main effect of self-efficacy explained significant amounts of variance in either interests or goals.

While the main effects of outcome expectations and *self-efficacy* did not explain significant portions of variance in either *interest* or *goals*, the main effects of *grade* and background contextual affordances (e.g. *family connection* and *has role model*) did explain variance in *interest*. Moreover, the interaction of *grade* by *self-efficacy* also explained variance in *interest* (see Figure 12). However, this study provided inconclusive support for the findings of Myers et al. (2010), Grossman and Porche (2014), and Leaper et al. (2012), all of which indicated that student views of math and science careers were influenced by supportive background contextual affordances. While the main effect of background contextual affordances (e.g. *family connection* and *has role model*), along with the two-way interaction between *family connection* and *has role model*, did explain significant amounts of variance in *interest*, this was not the case for *goals*.

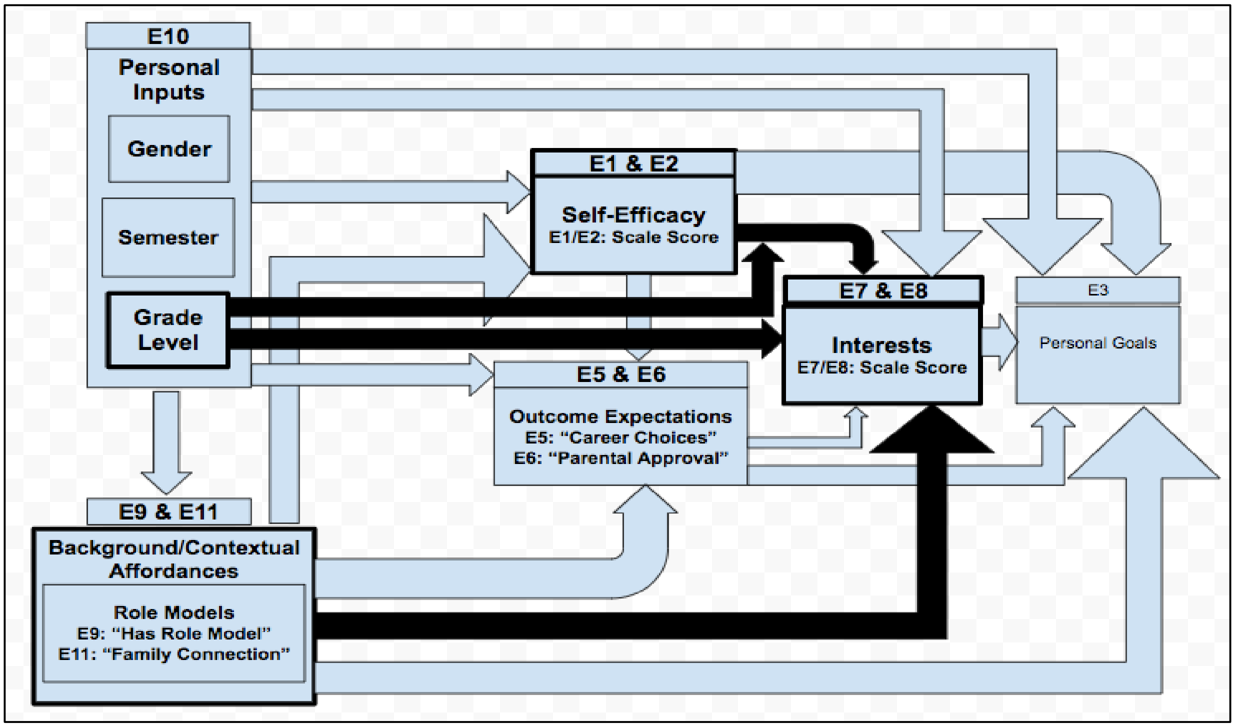

Figure 12. Linking theoretical model of SCCT with confirmed main effects and interactions. Dependent variable: *Interest*. Independent variables: Self-Efficacy, *has role model*, *family connection*, and Grade-Level (adapted from Lent et al. 1994, 2000).

5.3. Conclusion

The research literature is overwhelmingly clear in its recognition of institutional and social barriers that prevent females from pursuing and persisting in mathematics-intensive fields. In an attempt to study this national issue, the present study utilized social cognitive career theory as a theoretical model to investigate the factors that could be associated with gender differences among students in a specialized engineering-based career academy vocational high school. This study provided only partial support to the research literature. When gender was considered in isolation, male students were found have a significantly higher mean goal score and a significantly higher mean interest score than did females (see Appendix P). However, when it was considered in combination with other variables in the SCCT model, its effect weakened drastically. The main effect of *gender* explained a significant but small (.2%) percent of the variance in goals and only when the model was limited to including *grade*, *interest* and *semester* as additional factors.

As illustrated in Figure 13, which details all significant main (black arrows) and two-way (grey arrows) interactions, the inclusion of additional factors caused the direct effect of gender on goals to disappear altogether. Gender did not directly explain any significant portion of the variance of interest in engineering when its effect was assessed in combination with the other two personal inputs variables, self-efficacy, and the two outcome expectations variables, or additionally with the two background contextual affordances variables. None of its main or two-way interaction effects even remotely approached significance. Gender is directly associated with differences in self-efficacy, and gender differences in self-efficacy provide a path for gender differences in interests which in turn relate to goals.

In addition, this study found that background contextual affordances (e.g. *family connection* and *has role model*) explained significant amounts of variance throughout the model, particularly for self-efficacy and interests. There was also an interaction between *family connection* and *has role model* that explained significant amounts of variance in both self-efficacy and in interests, along with an interaction between *gender* and *has role model* that explained significant amounts of variance in outcome expectations (e.g. *career choice*). These findings indicate that Union County Magnet High School students' aspirations, and determinants of aspirations, are affected by factors outside of the school's immediate influence. Therefore, in fostering greater engineering-related interest among its students, Union County Magnet High School would be wise to consider opportunities that seek out and develop partnerships with the outside-of-the-school role models and family connections that are affecting students' self-efficacy, outcome expectations, and engineering-related interests.

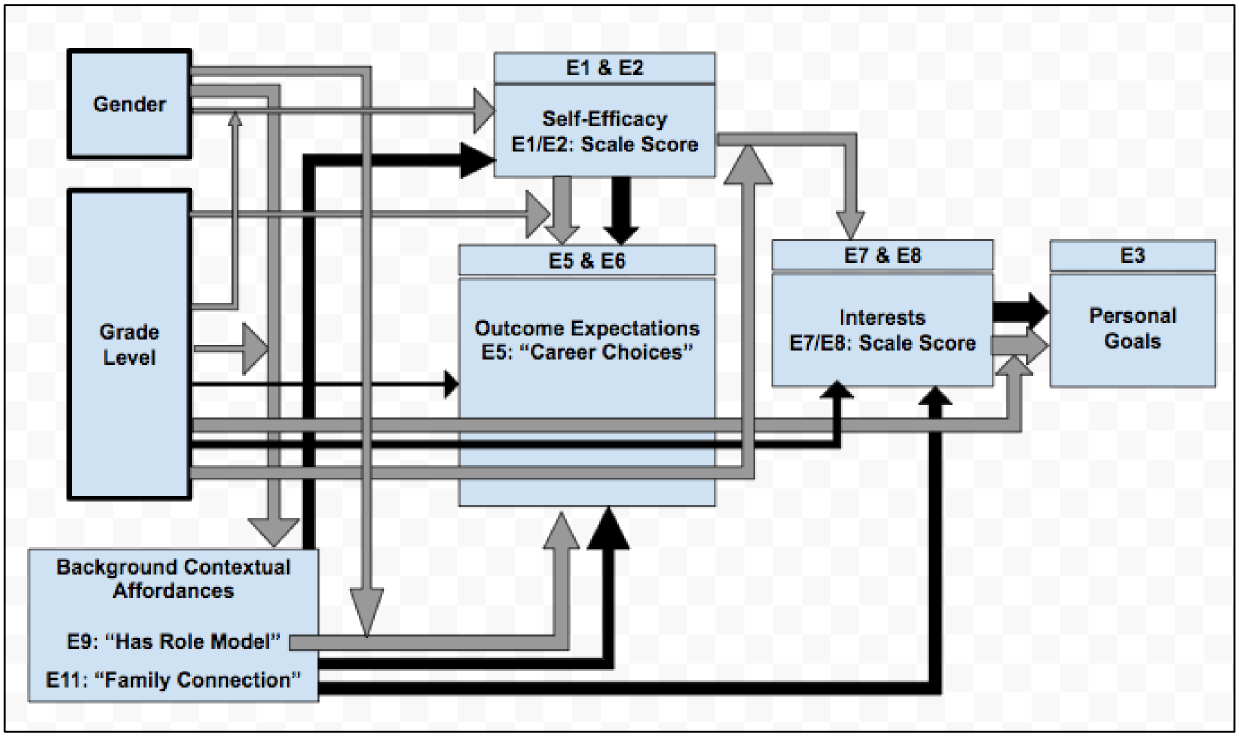

Figure 13. Linking theoretical model of SCCT with ALL confirmed main effects and interactions (adapted from Lent et al. 1994, 2000).

5.4. Limitations

This study acknowledges several limitations. First, since this study does not track students following graduation from UCMHS, persistence in engineering while in college or university falls beyond the scope of this study. Second, while 260 of the 304 students agreed to participate in this study (85.5%), four students did not participate in the fall 2017 administration and six students did not participate in the spring 2017 administration. Further, the percentage of students who participated in both the fall 2017 and spring 2018 administrations generally decreased with each subsequent grade-level. This decrease in administration is also the case from fall 2017 to spring 2018. For instance, for the class of 2021 through the class of 2018, the fall 2017 survey participation percentage was 96.1% (74/77), 83.8% (67/80), 77.9%, (60/77) and 78.6% (55/70), while the spring 2018 survey participation percentage was 93.5% (72/77), 85.0% (68/80), 77.9% (60/77), and 77.1% (54/70). However, this pattern might reflect differences in who responds across the grade levels, which could bias grade-level comparisons.

The third limiting factor involved the inability to match student responses across the fall and spring sample. The survey instrument did not include a student identifier, such as a name or a school identification number that would have provided a means to investigate matched pairs. Instead, similar to the comparison of survey responses from political polls at two different times, these findings were based on an analysis of fall and spring samples, even though it is recognized that there was very little difference in sample composition.

Finally, extreme caution should be exercised in applying the findings from this one school to similar schools elsewhere or to the broader population of high school students in New Jersey or nationally, particularly since Union County Magnet High School is a specialized career academy vocational high school that admits students through a selective admissions process. The extent to which this study's findings can inform policy initiatives aimed at reducing the gender gap in engineering career paths more generally will depend on the integration of these findings including the application of broader literature.

5.5. Implications for Practice

While the findings for this study require extreme caution when considering the generalizability across educational arenas, there are a number of potential implications for practice that will be considered when deciding the long-term curricular focus and recruiting strategies for Union County Magnet High School. First, the findings of this study document the strong relationship between interests and goals. It seems clear that setting goals with respect to a particular career field reflects a commitment and a clear intention to pursue such a career. This commitment is conducive, if not essential, to persevering through the difficult course of study in college required to embark on a career in engineering and in other mathematics-intensive STEM-based fields. Optimizing the allocation of the limited number of slots available in career academy vocational high schools like Union County Magnet High School entails recruiting those students most likely to have the highest motivation to persevere beyond high school to acquire the necessary qualifications for the fields for which such schools offer preparation. The challenge is the likelihood that few students have developed firm career intentions by the end of eighth-grade when career academy vocational high school selection decisions are made. Consequently, selection might consider including admission criteria that rely on predictors of such career intentions, if only for data collection. The strong relationship between interests and goals documented in this study suggests that in selecting students for career academy vocational high schools like Union County Magnet High School, which offer programs that prepare students for STEM-based fields, heavy emphasis should be placed on assessing candidates' level of interest in the fields of study offered.

Second, an incidental finding of this study was that between ninth-grade and twelfth-grade, the mean levels of interest and goals declined significantly and substantially for females (-22% and -20%, respectively, $p < .01$ in both cases) but not for males (-3% in both cases, nonsignificant). Both genders had nonsignificantly different levels of interest and goals in ninth-grade, but scores on both measures for twelfth-grade females were significantly lower than those for males in that grade. Although this was not a longitudinal study, mean interest and goal scores for females declined over the four years, indicating a cumulating effect of some negative influence on their interest in and intentions for an engineering career. The nature of this negative influence on females should be identified and the degree to which it affects other career academy vocational high schools that offer STEM-based programs should be ascertained. If it is found to be a problem that extends beyond this program in this specific school, efforts should be made to disseminate awareness of it and to determine whether and how to address it. This strategy may provide guidance in addressing the gender gap that exists in mathematics-intensive career fields like engineering.

5.6. Recommendations for Future Research

The findings from this study indicate that additional research is worthy of consideration, particularly since more questions were raised than were answered. First, this study utilized a quantitative methodology, using descriptive statistics and multifactorial analysis of covariance, to investigate how social cognitive career theory variables predict engineering aspirations among students in an engineering-based career academy vocational high school. This present study would benefit from a qualitative component involving a number of community stakeholders. For instance, since the student body consists of approximately 300 students, with each grade only having between 70 and 80 students, a set of grade-level focus groups and semi-structured interviews might provide a level of student voice that was inherently difficult to measure from a survey instrument. This might shed additional light on what makes the school both the same and different from what is generally reported in the research literature with respect to gender differences in interests and goals. For instance, perhaps it is the conglomeration of academically like-minded students, socially accepting behaviors, close-knit community, project-based and human-centered design elements to the curricula, or the quality of the instructional staff that explained the differences, but conversations with students would better answer these questions.

Secondly, it was intended to utilize this survey instrument again in fall 2021 since that will mark the first school year in which no students will have taken the survey. This second administration will not only include a qualitative component, but will also include a student identifier to match the student responses across the fall and spring administration. Data from this administration will continue to inform and guide curricular decisions within the school, particularly with respect to the instructional and assessment practices employed by the teachers. Moreover, these data will be shared and discussed during faculty and other school-related meetings for the purpose of identifying continued improvement efforts pertaining to the engineering-based vocational program.

Finally, it is likely that the effect of gender on engineering career-related interest and goals is mediated by intervening terms in the SCCT model. Consequently, future research should investigate the existence of these possible mediation effects to shed further light on the mechanisms through which gender influences career-related interests and intentions in regard to both engineering and other vocations.

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APPENDICES

APPENDIX A

2017-2018 Engineering Career Interest Survey

2017-2018 Engineering Career Interest Survey

QUESTIONS RESPONSES 256

Section 1 of 3

2017-2018 Engineering Career Interest Survey

Please answer the following questions. You must respond to every question. All responses are anonymous.

E10

What Grade are you in? *

- 9
- 10
- 11
- 12

E10

To which gender identity do you most identify? *

- Male
- Female
- Prefer Not to Answer

E10

Please specify your Race/Ethnicity *

- White
- Hispanic/Latino/a
- Black or African American
- Native American or American Indian
- Asian/Pacific Islander
- Other

After section 1 Continue to next section

Section 2 of 3

Engineering Survey Questions

Description (optional)

Engineering

Description (optional)

E1 I am able to do well in activities that involve engineering *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

E2 I am able to complete activities that involve engineering *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

E3 I plan to use engineering in my future career *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

E4 I will work hard on activities at school that involve engineering *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

E5 If I learn a lot about engineering, I will be able to do lots of different types of careers *

Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

E6 My parents would like it if I choose an engineering career *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

E7 I am interested in careers that involve engineering *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

E8 I like activities that involve engineering *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

E9 I have a role model in an engineering career *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

E10 I would feel comfortable talking to people who are engineers *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

E11 I know of someone in my family who is an engineer *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

After section 2 Continue to next section

Section 3 of 3

Thank you for participating in our survey!

Description (optional)

APPENDIX B

Descriptive statistics for Goals by Grade, Gender, and Semester

		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	3.81	1.116	47	3.39	1.146	44
	Female	3.48	1.475	25	3.36	1.524	25
	Grade 9 Total	3.69	1.252	72	3.38	1.285	69
10	Male	3.48	1.153	29	3.45	1.362	31
	Female	3.05	1.161	38	3.03	1.236	37
	Grade 10 Total	3.24	1.169	67	3.22	1.303	68
11	Male	3.73	1.098	33	3.48	1.253	33
	Female	3.48	1.122	27	3.11	1.219	27
	Grade 11 Total	3.62	1.106	60	3.32	1.242	60
12	Male	3.44	1.625	32	3.59	1.476	29
	Female	2.62	1.499	21	2.50	1.711	22
	Grade 12 Total	3.11	1.613	53	3.12	1.657	51
Total	Male	3.64	1.249	141	3.47	1.284	137
	Female	3.17	1.320	111	3.02	1.414	111
	Total	3.43	1.299	252	3.27	1.359	248

APPENDIX C

Descriptive statistics for Interests by Grade, Gender, and Semester

		Fall			Spring		
Grade	Gender	Mean	SD	N	Mean	SD	N
9	Male	3.85	0.983	47	3.69	0.864	44
	Female	3.64	1.186	25	3.52	1.15	25
	Grade 9 Total	3.78	1.054	72	3.63	0.973	69
10	Male	3.74	1.006	29	3.61	1.108	31
	Female	3.21	1.113	38	3.26	1.158	37
	Grade 10 Total	3.44	1.092	67	3.42	1.142	68
11	Male	3.88	0.91	33	3.65	1.196	33
	Female	3.17	1.217	27	2.96	1.117	27
	Grade 11 Total	3.56	1.109	60	3.34	1.202	60
12	Male	3.72	1.231	32	3.66	1.203	29
	Female	2.86	1.534	21	2.75	1.594	22
	Grade 12 Total	3.38	1.41	53	3.26	1.443	51
Total	Male	3.80	1.024	141	3.66	1.069	137
	Female	3.23	1.252	111	3.14	1.258	111
	Total	3.55	1.164	252	3.43	1.183	248

APPENDIX D

ANCOVA of Goals by Gender, Semester, and Grade with Interests

	Parameter Estimates							
Source	Parameter	*B*	df	Mean Square	F	Sig.	Partial Eta^2	Eta^2
Gender	[Gender=0]	-.295	1	2.457	.002	.023	.011	.002
	[Gender=1]	0[a]						
Semester	[Semester=1]	-.031	1	.11	.000	.631	.000	.000
	[Semester=2]	0[a]						
Grade	[Grade=9]	-.240	3	2.318	.007	.002	.030	.007
	[Grade=10]	.298						
	[Grade=11]	.929						
	[Grade=12]	0[a]						
Interests	Interests	.973	1	585.815	.551	<.001	.719	.551
Gender * Grade	[Gender=0] * [Grade=9]	-.126	3	.602	.002	.285	.008	.002
	[Gender=0] * [Grade=10]	-.058						
	[Gender=0] * [Grade=11]	-.346						
	[Gender=0] * [Grade=12]	0[a]						
	[Gender=1] * [Grade=9]	0[a]						
	[Gender=1] * [Grade=10]	0[a]						
	[Gender=1] * [Grade=11]	0[a]						
	[Gender=1] * [Grade=12]	0[a]						
Gender * Interests	[Gender=0] * Interests	.115	1	2.082	.002	.037	.009	.002
	[Gender=1] * Interests	0[a]						
Gender * Semester	[Gender=0] * [Semester=1]	-.062	1	.11	.000	.631	.000	.000
	[Gender=0] * [Semester=2]	0[a]						
	[Gender=1] * [Semester=1]	0[a]						
	[Gender=1] * [Semester=2]	0[a]						
Grade * Interests	[Grade=9] * Interests	.059	3	1.629	.005	.017	.021	.005
	[Grade=10] * Interests	-.088						
	[Grade=11] * Interests	-.183						
	[Grade=12] * Interests	0[a]						
Semester * Grade	[Semester=1] * [Grade=9]	.286	3	.488	.001	.38	.006	.001
	[Semester=1] * [Grade=10]	.108						
	[Semester=1] * [Grade=11]	.237						

Source	Parameter Estimates: Parameter	*B*	df	Mean Square	F	Sig.	Partial Eta^2	Eta^2
	[Semester=1] * [Grade=12]	0[a]						
	[Semester=2] * [Grade=9]	0[a]						
	[Semester=2] * [Grade=10]	0[a]						
	[Semester=2] * [Grade=11]	0[a]						
	[Semester=2] * [Grade=12]	0[a]						
Semester * Interests	[Semester=1] * Interests	-.016	1	.041	.000	.769	.000	.000
	[Semester=2] * Interests	0[a]						
Error			481	.475				

Note: Significant Effect R Squared = .567 (Adjusted Significant Effect R Squared = .563)
[a] reference category of categorical variable; no parameter estimate

APPENDIX E

ANCOVA of Goals by Gender, Semester, and Grade with Interests, Self-Efficacy, and Outcome Expectations

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	[Gender=0]	-.277	1	.311	.68	.41	.001	.001
	[Gender=1]	0[a]						
Semester	[Semester=1]	.143	1	.310	.677	.411	.001	.001
	[Semester=2]	0[a]						
Grade	[Grade=9]	.289	3	.517	1.128	.337	.007	.006
	[Grade=10]	.886						
	[Grade=11]	.774						
	[Grade=12]	0[a]						
Interests	Interests	1.229	1	12.75	27.83	.000	.057	.051
Self-efficacy	Self-efficacy	.032	1	.077	.169	.681	.000	.000
Career choices	Career choices	-.246	1	1.355	2.958	.086	.006	.005
Parental approval	Parental approval	-.265	1	1.353	2.953	.086	.006	.005
Gender * Grade	[Gender=0] * [Grade=9]	-.067	3	.337	.737	.531	.005	.004
	[Gender=0] * [Grade=10]	-.018						
	[Gender=0] * [Grade=11]	-.252						
	[Gender=0] * [Grade=12]	0[a]						
	[Gender=1] * [Grade=9]	0[a]						
	[Gender=1] * [Grade=10]	0[a]						
	[Gender=1] * [Grade=11]	0[a]						
	[Gender=1] * [Grade=12]	0[a]						
Gender * Interests	[Gender=0] * Interests	.146	1	1.649	3.599	.058	.008	.007
	[Gender=1] * Interests	0[a]						
Gender * Career choices	[Gender=0] * Career choices	-.381	1	1.268	2.766	.097	.006	.005
	[Gender=1] * Career choices	-.246						
Gender * Parental approval	[Gender=0] * Parental approval	-.263	1	.001	.001	.972	.000	.000
	[Gender=1] * Parental approval	-.265						
Gender * Self-efficacy	[Gender=0] * Self-efficacy	.126	1	.362	.79	.375	.002	.001
	[Gender=1] * Self-efficacy	.032						
Gender * Semester	[Gender=0] * [Semester=1]	-.040	1	.041	.089	.766	.000	.000
	[Gender=0] * [Semester=2]	0[a]						
	[Gender=1] * [Semester=1]	0[a]						
	[Gender=1] * [Semester=2]	0[a]						
Grade * Interests	[Grade=9] * Interests	.177	3	1.813	3.958	.008	.025	.022
	[Grade=10] * Interests	-.011						
	[Grade=11] * Interests	-.188						
	[Grade=12] * Interests	0[a]						

	Parameter Estimates								
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2	
Grade * Career choices	[Grade=9] * Career choices	-.002	3	.773	1.688	.169	.011	.009	
	[Grade=10] * Career choices	-.079							
	[Grade=11] * Career choices	.168							
	[Grade=12] * Career choices	0[a]							
Grade * Parental approval	[Grade=9] * Parental approval	-.006	3	.118	.258	.856	.002	.001	
	[Grade=10] * Parental approval	.062							
	[Grade=11] * Parental approval	.034							
	[Grade=12] * Parental approval	0[a]							
Grade * Self-efficacy	[Grade=9] * Self-efficacy	-.239	3	.487	1.063	.364	.007	.006	
	[Grade=10] * Self-efficacy	-.202							
	[Grade=11] * Self-efficacy	-.175							
	[Grade=12] * Self-efficacy	0[a]							
Semester * Grade	[Semester=1] * [Grade=9]	.287	3	.456	.996	.395	.006	.002	.005
	[Semester=1] * [Grade=10]	.229							
	[Semester=1] * [Grade=11]	.266							
	[Semester=1] * [Grade=12]	0[a]							
	[Semester=2] * [Grade=9]	0[a]							
	[Semester=2] * [Grade=10]	0[a]							
	[Semester=2] * [Grade=11]	0[a]							
	[Semester=2] * [Grade=12]	0[a]							
Interests * Career choices	Interests * Career choices	-.027	1	.224	.488	.485	.001	.001	
Interests * Parental approval	Interests * Parental approval	-.050	1	1.09	2.382	.123	.005	.004	
Interests * Self-efficacy	Interests * Self-efficacy	-.041	1	.332	.724	.395	.002	.001	
Semester * Interests	[Semester=1] * Interests	.057	1	.254	.554	.457	.001	.001	
	[Semester=2] * Interests	0[a]							
Career choices * Parental approval	Career choices * Parental approval	.106	1	4.36	9.511	.002	.020	.017	
Self-efficacy * Career choices	Self-efficacy * Career choices	.032	1	.188	.41	.522	.001	.001	
Semester * Career choices	[Semester=1] * Career choices	-.058	1	.256	.559	.455	.001	.001	
	[Semester=2] * Career choices	0[a]							
Self-efficacy * Parental approval	c * Parental approval	.027	1	.2	.436	.509	.001	.001	
Semester * Parental approval	[Semester=1] * Parental approval	-.062	1	.449	.981	.322	.002	.002	
	[Semester=2] * Parental approval	0[a]							
Semester * Self-	[Semester=1] * Self-efficacy	-.013	1	.009	.02	.887	.000	.000	

Source	Parameter Estimates							
	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
efficacy	[Semester=2] * Self-efficacy	0[a]						
Error				.458				

Note: Significant Effect R Squared = .090 (Adjusted Significant Effect R Squared = .077)
[a] reference category of categorical variable; no parameter estimate

APPENDIX F

ANCOVA of Goals by Gender, Semester, and Grade with Interests, Self-Efficacy, Outcome Expectations, and Background Contextual Affordances

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	0.002	-.406	1	.388	.859	.355	.002	.002
		0[a]						
Semester	0.002	.212	1	.412	.911	.340	.002	.002
		0[a]						
Grade	0.007	.478	3	.582	1.288	.278	.009	.007
		.940						
		.912						
		0[a]						
Interests	0.037	1.111	1	8.873	19.625	.000	.043	.037
Self-efficacy	0.000	.157	1	.001	.002	.968	.000	.000
Career choices	0.004	-.218	1	1.058	2.341	.127	.005	.004
Parental approval	0.006	-.263	1	1.502	3.323	.069	.008	.006
Has role model	0.002	.174	1	.485	1.072	.301	.002	.002
Family connection	0.001	-.157	1	.204	.452	.502	.001	.001
Gender * Semester	0.000	-.031	1	.024	.053	.817	.000	.000
		0[a]						
		0[a]						
		0[a]						
Gender * Grade	0.003	-.001	3	.219	.485	.693	.003	.003
		.072						
		-.146						
		0[a]						
		0[a]						
		0[a]						
		0[a]						
		0[a]						
Semester * Grade	0.004	.236	3	.346	.765	.514	.005	.004
		.239						
		.239						
		0[a]						
		0[a]						
		0[a]						
		0[a]						
		0[a]						
Gender * Interests	0.004	.123	1	1.052	2.327	.128	.005	.004

Source	Parameter Estimates Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
		0[a]						
Gender * Self-efficacy	0.001	.065 0[a]	1	.159	.353	.553	.001	.001
Gender * Career choices	0.005	-.144 0[a]	1	1.301	2.878	.091	.007	.005
Gender * Parental approval	0.001	-.048 0[a]	1	.226	.499	.480	.001	.001
Gender * Has role model	0.004	.091 0[a]	1	1.072	2.371	.124	.005	.004
Gender * Family connection	0.004	.066 0[a]	1	.866	1.916	.167	.004	.004
Semester * Interests	0.001	.060 0[a]	1	.269	.596	.441	.001	.001
Semester * Self-efficacy	0.000	-.038 0[a]	1	.070	.155	.694	.000	.000
Semester * Career choices	0.001	-.057 0[a]	1	.245	.541	.462	.001	.001
Semester * Parental approval	0.001	-.054 0[a]	1	.330	.729	.394	.002	.001
Semester * Has role model	0.000	.019 0[a]	1	.054	.119	.731	.000	.000
Semester * Family connection	0.000	-.014 0[a]	1	.049	.108	.743	.000	.000
Grade * Interests	0.017	.158 .021 -.168 0[a]	3	1.350	2.986	.031	.020	.017
Grade * Self-efficacy	0.008	-.295 -.243 -.177 0[a]	3	.636	1.406	.240	.010	.008
Grade * Career choices	0.011	.021 -.121	3	.869	1.923	.125	.013	.011

Source	Parameter Estimates Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
		.153						
		0[a]						
Grade * Parental approval	0.001	-.010	3	.040	.089	.966	.001	.001
		.036						
		.011						
		0[a]						
Grade * Has role model	0.002	-.050	3	.191	.423	.736	.003	.002
		-.014						
		-.080						
		0[a]						
Grade * Family connection	0.002	.043	3	.186	.412	.744	.003	.002
		.068						
		.022						
		0[a]						
Interests * Self-efficacy	0.001	-.026	1	.121	.268	.605	.001	.001
Interests * Career choices	0.000	-.017	1	.075	.166	.684	.000	.000
Interests * Parental approval	0.005	-.055	1	1.172	2.593	.108	.006	.005
Interests * Has role model	0.002	.034	1	.573	1.267	.261	.003	.002
Interests * Family connection	0.001	-.017	1	.197	.435	.510	.001	.001
Self-efficacy * Career choices	0.000	.023	1	.086	.191	.662	.000	.000
Self-efficacy * Parental approval	0.002	.041	1	.413	.914	.339	.002	.002
Self-efficacy * Has role model	0.006	-.066	1	1.346	2.978	.085	.007	.006
Self-efficacy * Family connection	0.000	.015	1	.087	.193	.661	.000	.000
Career choices * Parental approval	0.012	.093	1	2.984	6.600	.011	.015	.012
Career choices * Has role model	0.002	-.031	1	.392	.867	.352	.002	.002
Career choices * Family connection	0.003	.034	1	.749	1.656	.199	.004	.003
Parental approval * Has	0.005	.039	1	1.145	2.533	.112	.006	.005

Source	Parameter Estimates Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
role model								
Parental approval * Family connection	0.001	-.017	1	.280	.619	.432	.001	.001
Has role model * Family connection	0.001	-.011	1	.226	.500	.480	.001	.001
Error		436.0	.452					

Note: Significant Effect R Squared = .067 (Adjusted Significant Effect R Squared = .049)

[a] reference category of categorical variable; no parameter estimate

APPENDIX G

ANCOVA of Interests by Gender, Semester, and Grade with Self-Efficacy and Outcome Expectations

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	-.053	1	.021	.03	.862	0	.000
	Gender=1	0[a]						
Semester	Semester=1	.017	1	.384	.566	.452	.001	.001
	Semester=2	0[a]						
Grade	Grade=9	1.534	3	2.267	3.338	.019	.021	.019
	Grade=10	.148						
	Grade=11	1.622						
	Grade=12	0[a]						
Self-efficacy	Self-efficacy	.411	1	.243	.357	.550	.001	.001
Career choices	Career choices	.176	1	1.237	1.822	.178	.004	.003
Parental approval	Parental approval	.046	1	.011	.017	.897	.000	.000
Gender * Grade	Gender=0 * Grade=9	-.072	3	.418	.615	.606	.004	.003
	Gender=0 * Grade=10	-.059						
	Gender=0 * Grade=11	.189						
	Gender=0 * Grade=12	0[a]						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Gender * Career choices	Gender=0 * Career choices	.047	1	1.405	2.07	.151	.004	.004
	Gender=1 * Career choices	.176						
Gender * Parental approval	Gender=0 * Parental approval	.144	1	1.267	1.866	.173	.004	.004
	Gender=1 * Parental approval	.046						
Gender * Self-efficacy	Gender=0 * Self-efficacy	.515	1	.608	.896	.344	.002	.002
	Gender=1 * Self-efficacy	.411						
Gender * Semester	Gender=0 * Semester=1	.256	1	1.778	2.619	.106	.006	.005
	Gender=0 * Semester=2	0[a]						
	Gender=1 * Semester=1	0[a]						
	Gender=1 * Semester=2	0[a]						
Grade * Career choices	Grade=9 * Career choices	.202	3	1.701	2.505	.058	.016	.014
	Grade=10 * Career choices	-.082						
	Grade=11 * Career choices	.164						
	Grade=12 * Career choices	0[a]						
	Grade=9 * Parental approval	-.117	3	1.907	2.809	.039	.018	.016

Source	Parameter Estimates: Parameter	B	df	Mean Square	F	p	Part. Eta²	Eta²
Grade * Parental approval	Grade=10 * Parental approval	.107						
	Grade=11 * Parental approval	-.143						
	Grade=12 * Parental approval	0[a]						
Grade * Self-efficacy	Grade=9 * Self-efficacy	-.428	3	3.336	4.913	.002	.031	.028
	Grade=10 * Self-efficacy	-.058						
	Grade=11 * Self-efficacy	-.503						
	Grade=12 * Self-efficacy	0[a]						
Semester * Grade	Semester=1 * Grade=9	.191	3	.548	.807	.49	.005	.005
	Semester=1 * Grade=10	.291						
	Semester=1 * Grade=11	.321						
	Semester=1 * Grade=12	0[a]						
	Semester=2 * Grade=9	0[a]						
	Semester=2 * Grade=10	0[a]						
	Semester=2 * Grade=11	0[a]						
	Semester=2 * Grade=12	0[a]						
Career choices * Parental approval	Career choices * Parental approval	.001	1	.002	.002	.962	0	.000
Self-efficacy * Career choices	Self-efficacy * Career choices	.032	1	.343	.506	.477	.001	.001
Semester * Career choices	Semester=1 * Career choices	.159	1	2.408	3.547	.060	.008	.007
	Semester=2 * Career choices	0[a]						
Self-efficacy * Parental approval	Self-efficacy * Parental approval	.062	1	1.366	2.012	.157	.004	.004
Semester * Parental approval	Semester=1 * Parental approval	-.067	1	.627	.923	.337	.002	.002
	Semester=2 * Parental approval	0[a]						
Semester * Self-efficacy	Semester=1 * Self-efficacy	-.177	1	1.937	2.852	.092	.006	.005
	Semester=2 * Self-efficacy	0[a]						
Error			466	.679				

Note: Significant Effect R Squared = .062 (Adjusted Significant Effect R Squared = .051)

[a] reference category of categorical variable; no parameter estimate

APPENDIX H

ANCOVA of Interests by Gender, Semester, and Grade with Self-Efficacy, Outcome Expectations, and Background Contextual Affordances

Source	Parameter Estimates: Parameter	Parameter Estimates: *B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	-.068	1	.003	.005	.946	.000	.000
	Gender=1	0[a]						
Semester	Semester=1	.11	1	.435	.667	.415	.001	.001
	Semester=2	0[a]						
Grade	Grade=9	1.97	3	2.486	3.809	.010	.025	.021
	Grade=10	.621						
	Grade=11	1.876						
	Grade=12	0[a]						
Self-efficacy	Self-efficacy	.425	1	.227	.347	.556	.001	.001
Career choices	Career choices	.110	1	.645	.988	.321	.002	.002
Parental approval	Parental approval	-.056	1	.056	.086	.769	.000	.000
Has role model	Has role model	.758	1	7.979	12.226	.001	.027	.022
Family connection	Family connection	-.347	1	3.744	5.737	.017	.013	.010
Gender * Grade	Gender=0 * Grade=9	-.187	3	.304	.466	.706	.003	.003
	Gender=0 * Grade=10	-.206						
	Gender=0 * Grade=11	-.018						
	Gender=0 * Grade=12	0[a]						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Gender * Family connection	Gender=0 * Family connection	-.367	1	.091	.139	.71	.000	.000
	Gender=1 * Family connection	-.347						
Gender * Career choices	Gender=0 * Career choices	.031	1	.476	.730	.393	.002	.001
	Gender=1 * Career choices	.11						
Gender * Parental approval	Gender=0 * Parental approval	.046	1	1.27	1.945	.164	.004	.004
	Gender=1 * Parental approval	-.056						
Gender * Has role model	Gender=0 * Has role model	.778	1	.056	.086	.769	.000	.000
	Gender=1 * Has role model	.758						
Gender * Self-efficacy	Gender=0 * Self-efficacy	.509	1	.362	.555	.457	.001	.001

Source	Parameter Estimates: Parameter	Parameter Estimates: *B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
	Gender=1 * Self-efficacy	.425						
Gender * Semester	Gender=0 * Semester=1	.27	1	1.916	2.936	.087	.007	.005
	Gender=0 * Semester=2	0[a]						
	Gender=1 * Semester=1	0[a]						
	Gender=1 * Semester=2	0[a]						
Grade * Family connection	Grade=9 * Family connection	-.094	3	.696	1.066	.363	.007	.006
	Grade=10 * Family connection	-.1						
	Grade=11 * Family connection	-.01						
	Grade=12 * Family connection	0[a]						
Grade * Career choices	Grade=9 * Career choices	.207	3	1.374	2.105	.099	.014	.012
	Grade=10 * Career choices	-.077						
	Grade=11 * Career choices	.094						
	Grade=12 * Career choices	0[a]						
Grade * Parental approval	Grade=9 * Parental approval	-.082	3	1.604	2.458	.062	.016	.013
	Grade=10 * Parental approval	.128						
	Grade=11 * Parental approval	-.124						
	Grade=12 * Parental approval	0[a]						
Grade * Has role model	Grade=9 * Has role model	-.024	3	.144	.221	.882	.001	.001
	Grade=10 * Has role model	-.019						
	Grade=11 * Has role model	.041						
	Grade=12 * Has role model	0[a]						
Grade * Self-efficacy	Grade=9 * Self-efficacy	-.457	3	3.267	5.006	.002	.033	.027
	Grade=10 * Self-efficacy	-.062						
	Grade=11 * Self-efficacy	-.498						
	Grade=12 * Self-efficacy	0[a]						
Semester * Grade	Semester=1 * Grade=9	.085	3	.34	.521	.668	.003	.003

Source	Parameter Estimates: Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
	Semester=1 * Grade=10	.164						
	Semester=1 * Grade=11	.269						
	Semester=1 * Grade=12	0[a]						
	Semester=2 * Grade=9	0[a]						
	Semester=2 * Grade=10	0[a]						
	Semester=2 * Grade=11	0[a]						
	Semester=2 * Grade=12	0[a]						
Career choices * Family connection	Career choices * Family connection	.035	1	.997	1.528	.217	.003	.003
Parental approval * Family connection	Parental approval * Family connection	.04	1	1.854	2.841	.093	.006	.005
Has role model * Family connection	Has role model * Family connection	-.052	1	5.208	7.981	.005	.018	.015
Self-efficacy * Family connection	Self-efficacy * Family connection	.045	1	.879	1.347	.246	.003	.002
Semester * Family connection	Semester=1 * Family connection	.003	1	.003	.005	.946	.000	.000
	Semester=2 * Family connection	0[a]						
Career choices * Parental approval	Career choices * Parental approval	.004	1	.012	.019	.891	.000	.000
Career choices * Has role model	Career choices * Has role model	-.018	1	.168	.258	.612	.001	.000
Self-efficacy * Career choices	Self-efficacy * Career choices	.024	1	.174	.267	.606	.001	.000
Semester * Career choices	Semester=1 * Career choices	.149	1	2.035	3.118	.078	.007	.006
	Semester=2 * Career choices	0[a]						
Parental approval * Has role model	Parental approval * Has role model	-.038	1	1.293	1.981	.160	.004	.004
Self-efficacy * Parental approval	Self-efficacy * Parental approval	.067	1	1.45	2.222	.137	.005	.004
Semester * Parental approval	Semester=1 * Parental approval	-.062	1	.5	.766	.382	.002	.001
	Semester=2 * Parental approval	0[a]						
Self-efficacy * Has role model	Self-efficacy * Has role model	-.055	1	1.032	1.581	.209	.004	.003
Semester * Has role model	Semester=1 * Has role model	-.029	1	.136	.208	.649	.000	.000
	Semester=2 * Has role model	0[a]						
Semester * Self-efficacy	Semester=1 * Self-efficacy	-.164	1	1.582	2.424	.120	.005	.004

Source	Parameter Estimates		*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
	Parameter	*B*						
	Semester=2 * Self-efficacy	0[a]						
Error			447	.653				

Note: Significant Effect R Squared = .096 (Adjusted Significant Effect R Squared = .081)

[a] reference category of categorical variable; no parameter estimate

APPENDIX I

ANCOVA of Outcome Expectations (Career Choices) by Gender, Semester, and Grade with Self-Efficacy and Background Contextual Affordances

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	.412	1	1.066	1.298	.255	.003	.002
	Gender=1	0[a]						
Semester	Semester=1	.469	1	1.202	1.463	.227	.003	.003
	Semester=2	0[a]						
Grade	Grade=9	3.005	3	6.854	8.344	<.001	.051	.045
	Grade=10	1.027						
	Grade=11	.779						
	Grade=12	0[a]						
Self-efficacy	Self-efficacy	.831	1	11.355	13.824	<.001	.029	.025
Has role model	Has role model	.191	1	.828	1.008	.316	.002	.002
Family connection	Family connection	.186	1	.935	1.138	.287	.002	.002
Gender * Grade	Gender=0 * Grade=9	-.187	3	.782	.952	.415	.006	.005
	Gender=0 * Grade=10	.165						
	Gender=0 * Grade=11	.14						
	Gender=0 * Grade=12	0[a]						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Gender * Family connection	Gender=0 * Q11	.282	1	2.165	2.635	.105	.006	.005
	Gender=1 * Q11	.186						
Gender * Has role model	Gender=0 * Has role model	.009	1	5.43	6.611	.010	.014	.012
	Gender=1 * Has role model	.191						
Gender * Self-efficacy	Gender=0 * Self-efficacy	.731	1	.595	.724	.395	.002	.001
	Gender=1 * Self-efficacy	.831						
Gender * Semester	Gender=0 * Semester=1	.209	1	1.226	1.492	.223	.003	.003
	Gender=0 * Semester=2	0[a]						
	Gender=1 * Semester=1	0[a]						
	Gender=1 * Semester=2	0[a]						

Source	Parameter Estimates: Parameter	Parameter Estimates: *B*	*df*	Mean Square	*F*	*p*	Part. Eta²	Eta²
Grade * Family connection	Grade=9 * Family connection	-.018	3	1.395	1.698	.167	.011	.009
	Grade=10 * Family connection	-.028						
	Grade=11 * Family connection	-.162						
	Grade=12 * Family connection	0[a]						
Grade * Has role model	Grade=9 * Has role model	.046	3	.92	1.12	.341	.007	.006
	Grade=10 * Has role model	.073						
	Grade=11 * Has role model	.168						
	Grade=12 * Has role model	0[a]						
Grade * Self-efficacy	Grade=9 * Self-efficacy	-.683	3	6.16	7.5	<.001	.046	.040
	Grade=10 * Self-efficacy	-.287						
	Grade=11 * Self-efficacy	-.169						
	Grade=12 * Self-efficacy	0[a]						
Semester * Grade	Semester=1 * Grade=9	-.051	3	.1	.122	.947	.001	.001
	Semester=1 * Grade=10	.04						
	Semester=1 * Grade=11	-.091						
	Semester=1 * Grade=12	0[a]						
	Semester=2 * Grade=9	0[a]						
	Semester=2 * Grade=10	0[a]						
	Semester=2 * Grade=11	0[a]						
	Semester=2 * Grade=12	0[a]						
Has role model * Family connection	Has role model * Family connection	-.029	1	1.765	2.149	.143	.005	.004
Self-efficacy * Family connection	Self-efficacy * Family connection	-.034	1	.583	.71	.4	.002	.001
Semester * Family connection	Semester=1 * Family connection	-.013	1	.045	.055	.815	.000	.000
	Semester=2 * Family connection	0[a]						
Self-efficacy * Has role model	Self-efficacy * Has role model	.008	1	.028	.034	.854	.000	.000
Semester * Has role model	Semester=1 * Has role model	.069	1	.873	1.062	.303	.002	.002

Source	Parameter Estimates							
	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
	Semester=2 * Has role model	0[a]						
Semester * Self-efficacy	Semester=1 * Self-efficacy	-.123	1	1.034	1.259	.262	.003	.002
	Semester=2 * Self-efficacy	0[a]						
Error			466	.821				

Note: Significant Effect R Squared = .121 (Adjusted Significant Effect R Squared = .116)

[a] reference category of categorical variable; no parameter estimate

APPENDIX J

ANCOVA of Outcome Expectations (Parental Approval) by Gender, Semester, and Grade with Self-Efficacy and Background Contextual Affordances

Source	Parameter Estimates: Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta²	Eta²
Gender	Gender=0	-.098	1	.179	.142	.707	.000	.000
	Gender=1	0[a]						
Semester	Semester=1	-.065	1	.106	.084	.773	.000	.000
	Semester=2	0[a]						
Grade	Grade=9	1.011	3	1.345	1.06	.364	.007	.006
	Grade=10	1.577						
	Grade=11	.654						
	Grade=12	0[a]						
Self-efficacy	Self-efficacy	.138	1	.148	.117	.733	.000	.000
Has role model	Has role model	.446	1	3.450	2.726	.099	.006	.006
Family connection	Family connection	-.315	1	2.924	2.311	.129	.005	.005
Gender * Grade	Gender=0 * Grade=9	-.051	3	.187	.148	.931	.001	.001
	Gender=0 * Grade=10	-.196						
	Gender=0 * Grade=11	-.099						
	Gender=0 * Grade=12	0[a]						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Gender * Family connection	Gender=0 * Family connection	-.368	1	.646	.511	.475	.001	.001
	Gender=1 * Family connection	-.315						
Gender * Has role model	Gender=0 * Has role model	.460	1	.035	.028	.867	.000	.000
	Gender=1 * Has role model	.446						
Gender * Self-efficacy	Gender=0 * Self-efficacy	.225	1	.464	.367	.545	.001	.001
	Gender=1 * Self-efficacy	.138						
Gender * Semester	Gender=0 * Semester=1	-.079	1	.174	.138	.711	.000	.000
	Gender=0 * Semester=2	0[a]						
	Gender=1 * Semester=1	0[a]						
	Gender=1 * Semester=2	0[a]						

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Grade * Family connection	Grade=9 * Family connection	.131	3	3.066	2.42	.065	.015	.015
	Grade=10 * Family connection	.021						
	Grade=11 * Family connection	-.127						
	Grade=12 * Family connection	0[a]						
Grade * Has role model	Grade=9 * Has role model	-.089	3	.315	.249	.862	.002	.002
	Grade=10 * Has role model	-.009						
	Grade=11 * Has role model	-.022						
	Grade=12 * Has role model	0[a]						
Grade * Self-efficacy	Grade=9 * Self-efficacy	-.258	3	1.451	1.14	.33	.007	.007
	Grade=10 * Self-efficacy	-.301						
	Grade=11 * Self-efficacy	-.032						
	Grade=12 * Self-efficacy	0[a]						
Semester * Grade	Semester=1 * Grade=9	.031	3	.903	.713	.544	.005	.004
	Semester=1 * Grade=10	-.311						
	Semester=1 * Grade=11	.045						
	Semester=1 * Grade=12	0[a]						
	Semester=2 * Grade=9	0[a]						
	Semester=2 * Grade=10	0[a]						
	Semester=2 * Grade=11	0[a]						
	Semester=2 * Grade=12	0[a]						
Has role model * Family connection	Has role model * Family connection	-.023	1	1.098	.868	.352	.002	.002
Self-efficacy * Family connection	Self-efficacy * Family connection	.084	1	3.683	2.91	.089	.006	.006
Semester * Family connection	Semester=1 * Family connection	.050	1	.647	.512	.475	.001	.001
	Semester=2 * Family connection	0[a]						
Self-efficacy * Has role model	Self-efficacy * Has role model	-.035	1	.496	.392	.532	.001	.001
Semester * Has role model	Semester=1 * Has role model	-.005	1	.004	.003	.953	.000	.000
	Semester=2 * Has role model	0[a]						

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Semester * Self-efficacy	Semester=1 * Self-efficacy	.032	1	.069	.055	.815	.000	.000
	Semester=2 * Self-efficacy	0[a]						
Error			466	1.265				

Note: Significant Effect R Squared = 0.0 (Adjusted Significant Effect R Squared = 0.0)

[a] reference category of categorical variable; no parameter estimate

APPENDIX K

ANCOVA of Self-Efficacy by Gender, Semester, and Grade with and Background Contextual Affordances

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	0[a]	1	.843	1.51	.220	.003	.003
	Gender=1	.023						
Semester	Semester=1	-.009	1	.351	.63	.428	.001	.001
	Semester=2	.002						
Grade	Grade=9	0[a]	3	1.13	2.024	.110	.013	.011
	Grade=10	.067						
	Grade=11	-.007						
	Grade=12	-.010						
Has role model	Has role model	.216	1	8.364	14.985	<.001	.031	.028
Family connection	Family connection	.120	1	5.564	9.969	.002	.021	.019
Gender * Grade	Gender=0 * Grade=9	0[a]	3	1.822	3.264	.021	.020	.018
	Gender=0 * Grade=10	-.505						
	Gender=0 * Grade=11	-.234						
	Gender=0 * Grade=12	-.151						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Gender * Family connection	Gender=0 * Family connection	0[a]	1	.001	.002	.965	.000	.000
	Gender=1 * Family connection	-.046						
Gender * Has role model	Gender=0 * Has role model	.018	1	.315	.564	.453	.001	.001
	Gender=1 * Has role model	0[a]						
Gender * Semester	Gender=0 * Semester=1	.002	1	1.027	1.84	.176	.004	.003
	Gender=0 * Semester=2	0[a]						
	Gender=1 * Semester=1	0[a]						
	Gender=1 * Semester=2	0[a]						
Grade * Family connection	Grade=9 * Family connection	.023	3	.05	.09	.966	.001	.001
	Grade=10 * Family connection	-.009						
	Grade=11 * Family connection	.002						

Source	Parameter Estimates: Parameter	Parameter Estimates: *B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
	Grade=12 * Family connection	0[a]						
Grade * Has role model	Grade=9 * Has role model	.067	3	.274	.49	.689	.003	.003
	Grade=10 * Has role model	-.007						
	Grade=11 * Has role model	-.01						
	Grade=12 * Has role model	0[a]						
Semester * Grade	Semester=1 * Grade=9	-.505	3	1.37	2.454	.063	.015	.014
	Semester=1 * Grade=10	-.234						
	Semester=1 * Grade=11	-.151						
	Semester=1 * Grade=12	0[a]						
	Semester=2 * Grade=9	0[a]						
	Semester=2 * Grade=10	0[a]						
	Semester=2 * Grade=11	0[a]						
	Semester=2 * Grade=12	0[a]						
Has role model * Family connection	Has role model * Family connection	-.046	1	4.713	8.443	.004	.018	.016
Semester * Family connection	Semester=1 * Family connection	.018	1	.089	.159	.690	.000	.000
	Semester=2 * Family connection	0[a]						
Semester * Has role model	Semester=1 * Has role model	.002	1	.001	.001	.975	.000	.000
	Semester=2 * Has role model	0[a]						
Error			474	.558				

Note: Significant Effect R Squared = .080 (Adjusted Significant Effect R Squared = .071)

[a] reference category of categorical variable; no parameter estimate

APPENDIX L

ANCOVA of Background Contextual Affordances (Has Role Model) by Gender, Semester, and Grade

	Parameter Estimates							
Source	Parameter	*B*	*df*	Mean Square	*F*	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	-.511	1	.08	.037	.848	.000	.000
	Gender=1	0[a]						
Semester	Semester=1	-.083	1	.042	.019	.89	.000	.000
	Semester=2	0[a]						
Grade	Grade=9	-.622	3	2.911	1.332	.263	.008	.008
	Grade=10	-.906						
	Grade=11	-.620						
	Grade=12	0[a]						
Gender * Grade	Gender=0 * Grade=9	.505	3	7.703	3.526	.015	.021	.021
	Gender=0 * Grade=10	.980						
	Gender=0 * Grade=11	1.183						
	Gender=0 * Grade=12	0[a]						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Gender * Semester	Gender=0 * Semester=1	-.260	1	2.04	.934	.334	.002	.002
	Gender=0 * Semester=2	0[a]						
	Gender=1 * Semester=1	0[a]						
	Gender=1 * Semester=2	0[a]						
Semester * Grade	Semester=1 * Grade=9	.621	3	2.403	1.1	.349	.007	.007
	Semester=1 * Grade=10	.213						
	Semester=1 * Grade=11	.093						
	Semester=1 * Grade=12	0[a]						
	Semester=2 * Grade=9	0[a]						
	Semester=2 * Grade=10	0[a]						
	Semester=2 * Grade=11	0[a]						
	Semester=2 * Grade=12	0[a]						
Error			487	2.185				

Note: Significant Effect R Squared = .021 (Adjusted Significant Effect R Squared = .011)

[a] reference category of categorical variable; no parameter estimate

APPENDIX M

ANCOVA of Background Contextual Affordances (Family Connection) by Gender, Semester, and Grade

	Parameter Estimates							
Source	Parameter	*B*	df	Mean Square	F	*p*	Part. Eta^2	Eta^2
Gender	Gender=0	3.712	1	2.665	.858	.355	.002	.002
	Gender=1	-1.045						
Semester	Semester=1	0[a]	1	.306	.098	.754	.000	.000
	Semester=2	.209						
Grade	Grade=9	0[a]	3	.559	.18	.910	.001	.001
	Grade=10	-.435						
	Grade=11	-.602						
	Grade=12	-.811						
Gender * Grade	Gender=0 * Grade=9	0[a]	3	13.709	4.413	.004	.026	.026
	Gender=0 * Grade=10	.701						
	Gender=0 * Grade=11	1.191						
	Gender=0 * Grade=12	1.650						
	Gender=1 * Grade=9	0[a]						
	Gender=1 * Grade=10	0[a]						
	Gender=1 * Grade=11	0[a]						
	Gender=1 * Grade=12	0[a]						
Gender * Semester	Gender=0 * Semester=1	0[a]	1	.013	.004	.949	.000	.000
	Gender=0 * Semester=2	.021						
	Gender=1 * Semester=1	0[a]						
	Gender=1 * Semester=2	0[a]						
Semester * Grade	Semester=1 * Grade=9	0[a]	3	.404	.13	.942	.001	.001
	Semester=1 * Grade=10	-.164						
	Semester=1 * Grade=11	-.241						
	Semester=1 * Grade=12	-.270						
	Semester=2 * Grade=9	0[a]						
	Semester=2 * Grade=10	0[a]						
	Semester=2 * Grade=11	0[a]						
	Semester=2 * Grade=12	0[a]						
Error			487	3.106				

Note: Significant Effect R Squared = .026 (Adjusted Significant Effect R Squared = .017)

[a] reference category of categorical variable; no parameter estimate

APPENDIX N

Variables Associated with Gender Differences

Variable	Gender	N	Mean	SD
Career choices	Male	278	3.97	.948
	Female	222	3.87	1.053
Parental approval	Male	278	3.54	1.135
	Female	222	3.47	1.195
Self-efficacy	Male	278	4.18	.695
	Female	222	3.91	.863
Has role model	Male	278	2.70	1.475
	Female	222	2.61	1.508
Family connection	Male	278	3.11	1.747
	Female	222	3.23	1.793

Variable	*t*	*df*	*p* (2-tailed)	Mean Difference
Career choices	1.176	498[a]	.240	.105
Parental approval	0.637	498[a]	.525	.067
Self-efficacy	3.847	498[a]	<.001	.268
Has role model	0.636	498[a]	.525	.085
Family connection	-0.715	498[a]	.475	-.114

[a] Equal variances assumed
[b] Equal variances not assumed

APPENDIX O

Correlations between Interest and Goals within Grades

Grade	Correlations of Interest & Goals	
9	Pearson Correlation	.867
	p (2-tailed)	<.001
	N	146
10	Pearson Correlation	.835
	p (2-tailed)	<.001
	N	135
11	Pearson Correlation	.793
	p (2-tailed)	<.001
	N	120
12	Pearson Correlation	.894
	p (2-tailed)	<.001
	N	109

APPENDIX P

Differences in Interest and Goals Due to Gender in Isolation

Descriptive Statistics:

Variable	Gender	N	Mean	SD
Interest	Male	278	3.73	1.047
	Female	222	3.19	1.253
Goals (Q3)	Male	278	3.55	1.267
	Female	222	3.09	1.367

Independent Samples *t*-test of Gender Differences in Interest and Goals:

Variable	*t*	*df*	*p* (2-tailed)	Mean Difference
Interests	5.193	429.65[b]	<.001	.545
Goals (Q3)	3.889	498[a]	<.001	.459

[a] Equal variances assumed
[b] Equal variances not assumed