EXPLORING COLLEGE ENGINEERING STUDENTS' CHOICES, EFFORT, PERSISTENCE, AND CONTINUATION FROM EXPECTANCY-VALUE THEORY'S PERSPECTIVE

A Dissertation Presented to the

Faculty of the College of Education

University of Houston

In Partial Fulfillment

of the Requirement for the Degree

Doctor of Philosophy

by

Fan Wu

December 2015

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Abstract

High attrition rate is one of the biggest challenges undergraduate STEM education faces (Gonzalez & Kuenzi, 2012). It is imperative for educators to understand the factors related to students' choice, persistence, and continuation in engineering majors and careers (Eris et al., 2010; Lichtenstein et al., 2007; Lichtenstein et al., 2009). From the perspective of expectancy-value theory, this study sought to investigate how college engineering students' perceptions (engineering self-efficacy, gender stereotype threat, and racial stereotype threat), expectancy for academic success in engineering, and engineering task values (attainment value, intrinsic value, utility value, and cost) relate to their choices (take more engineering courses in the future, delay, and miss deadlines), effort and persistence in engineering coursework, and continuation in the field of engineering. The researcher recruited 163 undergraduate engineering students from a large southern urban university who completed a paper-and-pencil survey in class. The researcher analyzed the data using IBM SPSS Statistics 22.

The researcher created the Expectancy for Academic Success Scale based on the modified version of the Revised Generalized Expectancy for Success Scale (Hale, Fiedler, & Cochran, 1992) and used it in her candidacy research. In this dissertation, the researcher modified the Expectancy for Academic Success Scale and made it appropriate to use in engineering contexts. The modified scale was named as the Expectancy for Academic Success in Engineering Scale. Principle component analysis (PCA) with varimax rotation revealed a three-factor solution. The three factors are *Expectancy for*

Successful Engineering Academic Relationships, *Expectancy for Completion of Engineering Academic Tasks,* and *Expectancy for Completion of Engineering Education*. PCA results showed that all the items had primary loadings over .7 and the communalities were all above .63. Analyses of the internal consistency yielded satisfactory results with adequate Cronbach's alpha of .75, .94, and .89 for each scale respectively.

Results showed that 1) academic level, self-reported GPA, and intrinsic value were negative predictors of delay; 2) self-reported GPA and expectancy for successful engineering academic relationships were negative predictors of missing deadlines, whereas cost was a positive predictor of missing deadlines; 3) academic level and stereotype threat were negative predictors of choice, whereas expectancy for completion of engineering academic tasks, expectancy for completion of engineering education, attainment value, and intrinsic value were positive predictors of choice; 4) academic level, expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, expectancy for completion of engineering education, intrinsic value, and cost were positive predictors of effort; 5) stereotype threat was a negative predictor of persistence, whereas academic level, self-reported GPA, and expectancy for completion of engineering academic tasks were positive predictors of persistence; and 6) underrepresented minority status was a negative predictor of continuation, whereas expectancy for completion of engineering academic tasks and expectancy for completion of engineering education were positive predictors of continuation.

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Chapter I

Introduction

Science, technology, engineering, and mathematics (STEM) are widely considered major drivers of innovation and thus have critical impact on long-term economic growth (Atkinson & Mayo, 2010). Burning Glass Technologies (2014) reported that there were 2.3 million entry-level job postings in STEM fields in the year of 2013. However, according to a policy report by the President's Council of Advisors on Science and Technology (PCAST, 2012), there are only about 300,000 graduates with bachelor or associate degrees in STEM fields each year, much fewer than the number of STEM graduates needed. PCAST also indicated that the United States would need an increasing number of STEM professionals in the next 10 years. There is a widespread belief that economic growth in the U.S. depends largely on its ability to produce STEM graduates, therefore, many organizations strongly advocate an increase in the number of students and professionals in STEM fields (National Academy of Science, 2005; National Science Board, 2007; National Governors Association, 2007; National Research Council, 2012).

There are many challenges to produce more STEM graduates, one of which is the high attrition rates in STEM majors (Gonzalez & Kuenzi, 2012). Out of all options, PCAST recommended that retaining more students in STEM disciplines would increase the supply of STEM professionals fastest and with the lowest associated cost. Business Higher Education Forum (2010) U.S. STEM Education Model also pointed out that a shortcut to increasing the number of professionals in STEM fields is to improve persistence in undergraduate STEM education. Recent statistics show that less than 40%

of the students who enroll as intended STEM majors actually graduate with a STEM degree (PCAST, 2012). If the number of students who switch to non-STEM majors or drop out of college could be reduced, the shortage of STEM professionals could be improved (Atkinson, 2012). For example, if the retention rate of STEM majors increases from 40% to 50%, 725,000 additional STEM professionals would be produced to supply the STEM job market (PCAST, 2012).

Innovative STEM Curriculum

Previous studies center on four lines of research related to student persistence in STEM fields: STEM curriculum, diversifying teaching methods, cognitive factors, and non-cognitive factors. Evidence shows that innovative STEM curriculum increases students' interest, engagement, academic choice (Gentile et al., 2014), and self-reported learning abilities (e.g., design a component or system, work effectively in teams) (Ybarra et al., 2011) in STEM fields. Examples of innovative STEM curriculum include a freshman interdisciplinary course that integrates major concepts in traditional mathematics, physics, chemistry, biology, and computer science courses (Gentile et al., 2014), a 2-year mathematics sequence for engineering students provided by the Engineering College and the Mathematics Department at Cornell University and the University of Utah (American Mathematical Society, 2015), and a year-long sequence of mathematics courses for students in the life sciences at Emory University and the University of Minnesota (American Mathematical Society, 2015).

Diversifying Teaching Methods

The second line of research emphasized teaching methods in STEM courses. Seymour and Hewitt (1997) found that 90% of students who switched out of STEM majors and 98% of students who switched out of engineering cited poor teaching as a factor. Instructors in STEM fields such as engineering and physics tend to make the first year boring, difficult, and painful for their students, saving the interesting and practical classes until later (Atkinson, 2012). Some high-achieving students leave STEM majors because of uninspiring introductory STEM courses, and low-achieving students who are interested in STEM majors usually have difficulties in introductory STEM courses without institutional academic assistance (PCAST, 2012). Underrepresented minorities (URMs) leave STEM fields due to various concerns, including an unwelcoming atmosphere from instructors in STEM courses (PCAST, 2012).

Until now, most STEM courses have been taught in the format of lectures, however, diversifying teaching methods has had positive effects on STEM education. For example, students in engineering classes using active and cooperative learning outperformed students in traditional lectures in retention, graduation, and pursuing advanced study in the field of engineering (Felder, Felder, & Dietz, 1998). Moreover, students who partnered with faculty in research were much less likely to leave STEM fields than students who did not (Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998). Small-group work had significant positive effects on students' academic achievement, attitudes toward learning the material, and persistence in STEM courses (Springer, Stanne, & Donovan, 1999), whereas oral presentations and writing assignments enhanced the retention of science learning (Rivard & Straw, 2000). Finally, lecture combined with discussion resulted in enhanced short-term retention (Morgan, Whorton, & Gunsalas, 2000). Therefore, instructors are encouraged to provide research courses, various forms of active student engagement, and learning assessment to improve their teaching methods in STEM courses (PCAST, 2012). They need to provide better teaching methods to make their courses more inspiring, provide more help to students, and create a welcoming atmosphere in their classrooms (PCAST, 2012).

Cognitive Factors

The third line of research focused on students' cognitive factors, which also play a critical role in their persistence in STEM fields. Evidence shows that students' cognitive factors such as high school and college GPA, AP exam scores, and SAT scores are related to their persistence in STEM fields. Students who receive a higher cumulative GPA (Ackerman, Kanfer, & Beier, 2013) and higher grades in STEM courses were more likely to complete STEM degrees (Maltese & Tai, 2011). Soldner et al. (2012) found that college grades were significantly positively related to students' self-reported retention in STEM majors. Ackerman, Kanfer, and Calderwood (2013) showed that AP Calculus credit and successful completion of three or more AP exams in STEM subjects were the most important predictors of students' persistence in STEM majors. High school GPA and SAT scores also predicted students' persistence in STEM disciplines (Rohr, 2012; Ackerman, Kanfer, & Beier, 2013). In related studies, students' high school GPA predicted their persistence in engineering disciplines (Levin & Wyckoff, 1991; Zhang et al., 2004) and their quantitative SAT scores significantly impacted their graduation from engineering programs (Zhang et al., 2004). Students' first-semester college GPA predicted their persistence in engineering majors (Schaefers, Epperson, & Nauta, 1997) and was related to whether they would earn a STEM degree (Crisp, Nora, & Taggart, 2009).

Non-Cognitive Factors

Besides cognitive factors, evidence shows that students' non-cognitive factors such as personality, identification, and involvement are also associated with their persistence in STEM fields. Personality traits were found to be significantly related to male engineering undergraduates' retention (Haemmerlie & Montgomery, 2012); specifically, openness and verbal self-concept were predictors of persistence and attrition in STEM fields (Ackerman, Kanfer, & Beier, 2013). Identification with science was a strong predictor of students' persistence in science (Estrada, Woodcock, Hernandez, Schultz, & Schultz, 2011). The availability of role models, especially faculty who are women and URMs, increases performance and retention of students from these groups (Marx & Roman, 2002; Lockwood, 2006; Cheryan, Siy, Vichayapai, Drury, & Kim, 2011). Students who engaged in discussions with peers, joined student organizations in STEM disciplines, and participated in undergraduate research programs were more likely to persist in STEM fields (Espinosa, 2011). Other studies have demonstrated that undergraduate research experience promotes students' interest in STEM careers and pursuit of STEM advanced degrees (Russell et al., 2007). For example, an undergraduate research program at Emory University influenced students' actual pursuit of graduate study and professional careers in science (Junge et al., 2010).

Motivation. In addition to the non-cognitive factors mentioned above, research has shown that many students switch from STEM majors because of greater interest in non-STEM subjects or a loss of interest in STEM fields (Seymour & Hewitt, 1997), which indicates a crucial role that motivation plays in STEM persistence and the importance of an achievement motivation approach to understand STEM persistence

(Perez, Cromley, & Kaplan, 2014). Some of the most well-known and comprehensive motivation theories, such as social cognitive theory (Bandura, 1986), social-cognitive career theory (Lent & Brown, 1996), goal orientation theory (Elliott & Dweck, 1988; Ames, 1992), and self-determination theory (Deci & Ryan, 1985) have extended our understanding of STEM persistence. For example, research found that students' persistence in STEM fields was predicted by various motivational factors including interest level (e.g., Le, Robbins, & Westrick, 2014), beliefs and confidence about one's ability to learn STEM subjects (e.g., Huang, Taddese, & Walter, 2000), math and science self-concept (Ackerman et al., 2013), self-efficacy (e.g., Sawtelle, Brewe, & Kramer, 2012; Simon, Aulls, Dedic, Hubbard, & Hall, 2015), achievement goals (e.g., Hernandez, Schultz, Estrada, Woodcock, & Chance, 2013; Deemer, Smith, Carroll, & Carpenter, 2014; Simon et al., 2015), mastery and organization (e.g., Ackerman et al., 2013), as well as perceived autonomous support (e.g., Hall & Webb, 2014; Simon et al., 2015).

Expectancy-value theory (EVT) is another interesting comprehensive motivation theory with focus on expectancy for success and subjective task values (Eccles et al., 1983), both of which are found to influence individuals' decisions to choose STEM fields (e.g., Bandura et al., 2001; Simpkins et al., 2006). However, it has not been extensively applied to further our understanding of STEM persistence. Bøe, Henriksen, Lyons, and Schreiner (2011) reviewed international research on young people's participation in STEM using individual components from the EVT model and concluded that the EVT model was "not only useful for understanding young people's participation in STEM, but for designing and evaluating initiatives" (p. 63). Though they didn't explicitly apply the EVT as a core theoretical framework, some research studies examined individual components of the EVT sporadically. For example, Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins (2012) applied the social cognitive career theory (SCCT) to investigate the roles of self-efficacy, outcome expectations, and goals play in career development. They found that first-year college students' outcome expectation and interest in STEM pursuits were significantly positively related to their STEM persistence.

An extensive literature search found that only three studies (e.g., Jones, Paretti, Hein, & Knott, 2010; Matusovich, Streveler, & Miller, 2010; Jensen & Sjaastad, 2013) applied the EVT as a core theoretical framework to systematically examine motivation and persistence in STEM fields. Jensen and Sjaastad (2013) examined how a Norwegian out-of-school mathematics program affected students' STEM motivation and why students participated and stayed in the program. They found that five factors in the model were important for STEM motivation: expectancy for success, attainment value, intrinsic value, utility value, and cost. Jones et al. (2010) examined first-year engineering students at a large state university and found that both utility value and intrinsic value predicted the likelihood that students would choose engineering careers after graduation. They concluded that these constructs of EVT are needed to understand students' achievement and career plans in engineering. Yet, both studies did not examine typical achievement behaviors in EVT, such as choice, effort, and persistence. Matusovich et al. (2010) applied the EVT and focused on subjective task values construct in a qualitative, longitudinal study of undergraduate students' choices to enroll and persist in engineering majors. They used case studies and found that attainment value was positively related to persistence, and value-related constructs (attainment value, intrinsic value, utility value, and cost) predicted students' choices to earn engineering degrees. They concluded that values are important in students' choices to become engineers. This study analyzed 11 participants using qualitative methods. Future research using quantitative methods to examine students' choice, effort, and persistence in STEM fields based on larger sample size through the lens of the EVT is needed.

As one of the major branches of STEM, engineering is worth examining not only because of its unique characteristics in student motivation, but also the challenges it faces nowadays. Although engineers remain one of the 10 hardest jobs to fill in the job market in the U.S. (Smith, 2013), and engineering is the major with the highest salary ($92,900) (U.S. Census Bureau, 2014), there is still a reduced number of engineering graduates during the past two decades (Ohland et al., 2008). In addition, engineering has the lowest female enrollment rate (17.9%) and URMs enrollment rate (16.1%) of all STEM majors (National Science Foundation, Division of Science Resource Statistics, 2009). Understanding the factors relating to persistence in engineering majors and careers may help to increase the number of engineering graduates (e.g., Eris et al., 2010; Lichtenstein et al., 2007; Lichtenstein et al., 2009). However, the EVT has received limited attention in studies of college engineering students. Li et al. (2008) applied the EVT to develop an instrument to measure perspectives of engineering education among college students and found that engineering students showed higher intrinsic value and societal utility value than non-engineering students. They suggested that the EVT is helpful for extending our understanding of persistence and career choice in engineering.

As such, the study described here sought to investigate the factors that may influence college engineering students' choices (take more engineering courses, delay, and missing deadlines), effort and persistence in engineering coursework, and continuation in the field of engineering from the perspective of the EVT. There are four main objectives of this study. The first objective develops a measure of expectancy for academic success in engineering and examines its psychometric property. The second objective examines the relationships among college engineering students' perceptions (engineering self-efficacy, gender stereotype threat, and racial stereotype threat), expectancy for academic success in engineering, and engineering task values (attainment value, intrinsic value, utility value, and cost) within the framework of the EVT. The third objective explores the motivational factors that may be associated with college engineering students' choices (take more engineering courses, delay, and missing deadlines), effort and persistence in engineering coursework, and continuation in the field of engineering from the perspective of the EVT. The last objective discerns whether stereotype threat may contribute to college engineering students' choices (take more engineering courses, delay, and missing deadlines), effort and persistence in engineering coursework, and continuation in the field of engineering from the perspective of the EVT. The following research questions were answered:

1. How many factors are there in the Expectancy for Academic Success in Engineering Scale? How reliable are they?
2. What are the relationships among college engineering students' perceptions (engineering self-efficacy, gender stereotype threat, and racial stereotype threat), expectancy for academic success in engineering, and engineering task values (attainment value, intrinsic value, utility value, and cost)?
3. How do college engineering students' perceptions, expectancy for academic success in engineering, and engineering task values predict their choices (take

more engineering courses, delay, and missing deadlines)?

4. How do college engineering students' perceptions, expectancy for academic success in engineering, and engineering task values predict their effort in engineering coursework?
5. How do college engineering students' perceptions, expectancy for academic success in engineering, and engineering task values predict their persistence in engineering coursework?
6. How do college engineering students' perceptions, expectancy for academic success in engineering, and engineering task values predict their continuation in the field of engineering?

The current study contributes to the literature in several ways. First, the creation and validation of the Expectancy for Academic Success in Engineering Scale provides opportunities for researchers to explain college STEM students' achievement behaviors from three components of expectancy for academic success. Second, the study applies the EVT as the framework to study the relationships among college engineering students' motivation and their achievement behaviors, which provides policy makers and professors with educational strategies to retain and increase undergraduate engineering students. Third, the study examines the effect of racial and gender stereotype threat on engineering achievement behaviors, which provides instructional strategies for professors. Fourth, the study adapts the Pure Procrastination Scale and supports a two-factor solution and examines two factors (e.g., delay and missing deadlines) underlying academic procrastination separately, which allows the researchers to provide additional evidence and valuable information on the relationships among motivational factors and the two aspects of academic procrastination.

Chapter II

Literature Review and Conceptual Framework

STEM education refers to teaching and learning in science, technology, engineering, and mathematics fields, which includes activities from pre-school to post-doctorate in classroom settings and other informal settings (Gonzalez & Kuenzi, 2012). STEM is everywhere and influences our daily experiences (Science Pioneers, 2015). Everyone needs STEM knowledge and STEM products play an increasingly important role in our daily life (Science Pioneers, 2015).

STEM education is frequently raised in policy debates and hundreds of bills were introduced to congress related to this topic (Gonzalez & Kuenzi, 2012). For children who grow up in the age of technology, STEM provides them the best career options and is key to wise decisions (Science Pioneers, 2015). In 2009, the Department of Labor listed the 10 most needed employees, and eight of these require a degree in STEM fields. According to the U. S. Department of Commerce, STEM occupations are growing at 17%, which is almost twice as much as other occupations. The Department of Labor also indicates that STEM related jobs tend to provide higher salaries than non-STEM related jobs.

STEM professionals solve the complex problems of the modern world. According to a policy report by the President's Council of Advisors on Science and Technology (PCAST, 2012), the U.S. will need one more million STEM professionals in the next 10 years in order to retain its competitiveness in this fast-changing global economy. Because of the importance of STEM in this country, we need to encourage students to take as many math and science courses in middle and high school as possible

(Science Pioneers, 2015). We should also encourage college students to choose STEM majors and pursue STEM careers after they graduate.

Current Issues in Undergraduate STEM Education

Postsecondary STEM education plays an important role in establishing future workforce in STEM fields (Chen, 2013). Multiple organizations have advocated an increase in the number and diversity of students and professionals in STEM disciplines (National Academy of Science, 2005; National Science Board, 2007; National Governors Association, 2007; National Research Council, 2012). Although the United States government funnels $4.3 billion annually into initiatives related to STEM education, several challenges must be noted before adopting any particular approach to promote STEM education (Huffington Post, 2014).

In the United States, one major challenge of undergraduate STEM education is the high attrition rates in STEM majors (Gonzalez & Kuenzi, 2012). By spring 2009, 28% of the bachelor's degree students who entered STEM fields between 2003 and 2009 had switched to a non-STEM discipline (Chen, 2013). More females switched from a STEM major to a non-STEM field (32%) than males (26%) (Chen, 2013). Most of the students switched after taking introductory science, math, and engineering courses (PCAST, 2012). Many of these students show initial interest in STEM subjects and are capable of the work; making them an excellent retention group from which to draw part of the additional one million STEM graduates (PCAST, 2012).

Another major challenge of undergraduate STEM education is consistent underrepresentation of women and underrepresented minorities (URMs: Blacks, Hispanics, and Native Americans) in STEM majors (National Science Foundation, Division of Science Resource Statistics, 2009). Nowadays, women and URMs constitute approximately 70% of college students, however, only about 45% of the undergraduate degrees in STEM subjects are awarded to women and URMs (PCAST, 2012). In the past 10 years, men are more likely than women to complete a STEM degree after declaring a STEM major and have earned more bachelor’s degrees in engineering, computer science, and physics than women (NSB, 2012). Women hold less than 25% of all STEM jobs in the U.S. (Huffington Post, 2014). Bachelor’s degrees in STEM fields are mostly earned by White and Asian students (Cromley et al., 2013); Black, Hispanic, Native American, and other non-White, non-Asian students are underrepresented in undergraduate STEM education (NSB, 2012). Therefore, women and URMs also make a large underutilized source of potential STEM graduates (PCAST, 2012).

Current Issues in Undergraduate Engineering Education

Among college students in all STEM majors, engineering students’ motivation has some unique characteristics compared to that of the science, technology, and mathematics majors (Veenstra, 2008). Veenstra found that confidence in math and science skills predicted engineering students’ first year GPA, whereas confidence in overall academic ability predicted science, technology, and mathematics students’ first year GPA. Moreover, only for engineering students was the career goal (e.g., become an engineer) a motivator and predictor of their first year GPA (Veenstra, 2008). As one of the major branches of STEM, engineering is worth examining not only because of its unique characteristics in student motivation, but also the challenges it faces nowadays. In the United States, engineers are in high demand in the job market and engineering positions remain one of the 10 hardest jobs to fill (Smith, 2013). Similar to all other

STEM majors, undergraduate engineering education faces two major challenges: 1) a reduced number of engineering graduates during the past two decades (Ohland et al., 2008); and 2) a lack of gender and ethnic diversity amongst engineering graduates (Chubin, May, & Babco, 2005). In 2004, only about a third of all bachelor's degrees were awarded to STEM majors (Babco & Ellis, 2007), indicating that even fewer bachelor's degrees were awarded to engineering majors. Among all STEM majors, engineering has the lowest enrollment rates for females (17.9%) and URMs (16.1%) (National Science Foundation, Division of Science Resource Statistics, 2009). Compared to men, women have high participation rates in life sciences and social/behavioral sciences in college (Babco & Ellis, 2007), but low levels of interest in engineering (Pryor, 2007). Among college students who chose engineering as their major, only 42% planned to pursue a career in engineering and 14% definitely did not plan to pursue an engineering career during their senior year (Lichtenstein et al., 2009).

Researchers have examined various approaches to increase the number of engineering graduates and enhance gender and ethnic diversity, such as curriculum innovation (e.g., Fantz, Miranda, & Siller, 2010), diversifying teaching methods (e.g., Martinez Cartas, 2012), and financial support (e.g., Lundy-Wagner et al., 2014; Wilson, 2012). For example, Fantz, Miranda, and Siller (2010) investigated a teacher preparation program, which used an accredited engineering curriculum and provided additional training in technology teaching. They found these teachers were more likely to use all steps of the engineering design process and mathematical and analytical methods to determine optimum solutions. Martínez Cartas (2012) tested a group of mining engineering students' implementation of an improved virtual learning environment and found higher attendance rate, lower dropout rate, and higher pass percentage among these students compared to others. Lundy-Wagner et al. (2014) found that students who enter engineering graduated from relatively privileged high schools. They concluded that students' decisions to enter engineering were influenced by gender, race, socioeconomic status, and the type of high school they attended. They recommended that stakeholders should continue promoting policies and practices that encourage women, URMs, and students from high poverty high schools to enter engineering. Louisiana State University has followed this recommendation and developed a very successful mentoring program for economically disadvantaged students in STEM disciplines, in which financial aid and strategic pairing of scholarships with mentoring and training programs are provided (Wilson, 2012).

Researchers found that students' cognitive factors influenced their persistence in engineering. For example, students' ACT scores (e.g., Haemmerlie & Montgomery, 2012), high school GPA (e.g., Levin & Wyckoff, 1991; Zhang et al., 2004), first-semester college GPA (e.g., Schaefers et al., 1997), and college GPA (e.g. Haemmerlie & Montgomery, 2012) predicted their persistence in engineering majors. Students' quantitative SAT scores significantly impacted their graduation from engineering programs (Zhang et al., 2004). Non-cognitive factors have been found to impact students' persistence in engineering during the past decade. Haemmerlie and Montgomery (2012) found that the traits of prudence and sociability significantly predicted male undergraduate engineering students' retention. Students who were more confident, had positive experiences with instructors and peers, and perceived engineering positively were more likely to be committed to engineering and less likely to be interested in other fields (Litzler & Young, 2012). Cech et al. (2011) found that professional role confidence, referring to "individuals' confidence in their ability to fulfill the expected roles, competencies, and identity features of a successful member of their profession" (p. 642) predicted engineering persistence behaviorally and intentionally and the lack of this confidence contributed to attrition among female engineering students.

Researchers have also examined strategies to increase the number of engineering graduates and develop gender and ethnic diversity from an achievement motivation approach, which is known to be an important approach to understand STEM persistence (Perez, Cromley, & Kaplan, 2014). Students' confidence in college-level math and science ability significantly predicted their persistence in engineering (Burtner, 2005). In a longitudinal study, Eris et al. (2010) found that confidence in math and science skills and intentions to complete an engineering major were related to persistence in engineering. French et al. (2005) examined two cohorts of engineering students and found that intrinsic motivation was positively related to persistence in engineering. Lent et al. (2003) examined students in an introductory engineering course and found that self-efficacy is a predictor of engineering students' outcome expectation, interest, choice goals, and persistence. Males' abilities to complete the required coursework, females' beliefs in getting good grades, and engineering career outcome expectations predicted engineering students' intentions to persist in their engineering program (Concannon & Barrow, 2010). Female students who reported high levels of self-efficacy, identified with the engineering profession, and were motivated by the novelty and challenges were more likely to persist in engineering careers (Buse, Bilimoria, & Perelli, 2013). Engineering students who had higher intentions to persist (Lee et al., 2015) and higher identification with engineering and engineering ability perceptions (Jones et al., 2013) were more likely to persist in engineering fields. Engineering self-efficacy and career aspirations were significant predictors of undergraduate Bangladeshi engineering students' persistence in engineering (Saifuddin, Dyke, & Rasouli, 2013).

Although these findings have extended our understanding of engineering persistence from the perspective of achievement motivation, limited research has applied the EVT as a theoretical framework to examine students' persistence in engineering. An extensive literature search found only two studies (e.g., Jones et al., 2010; Matusovich et al., 2010) that applied the EVT to examine students' persistence and career choices in engineering, yet both have limitations. Jones et al. (2010) examined engineering students' belief about their future career, but did not examine some typical achievement behaviors, such as choice, effort, and persistence in engineering. Matusovich et al. (2010) found that students' task value contributed to students' choices to earn engineering degrees but failed to provide a quantitative perspective. Therefore, further research that examines engineering students' achievement behaviors (e.g. choice, effort, persistence) from the perspective of the EVT and can provide more generable results based on quantitative measures is needed.

Expectancy-Value Theory (EVT)

Expectancy-value theory (EVT) of achievement choice, as one of the most pervasive achievement motivation theories, provides a comprehensive framework for understanding individuals' social and academic experiences, values and beliefs, achievement-related choice and behavior (Wigfield, 1994). Eccles et al. (1983) originally developed the theory to study children's performance and choice in mathematics and proposed that students' expectancies for success on the tasks and perceived task values predicted their achievement-related choice. A more recent version of the model (Wigfield & Eccles, 2000) states that students' expectancies for success and subjective task values are assumed to influence their achievement choices as well as their academic engagement, such as effort and persistence. That is, students who believe that they would perform well on upcoming tasks in the future and/or feel the tasks are important, interesting, or useful are likely to present more positive achievement-related behaviors such as putting forth greater effort and persisting on tasks.

Perceived prior experiences and socialization influences also affected task specific beliefs (e.g., ability beliefs, difficulty levels of different tasks) (see Eccles et al., 1983, Eccles et al., 1998, and Wigfield & Eccles 1992; as cited in Wigfield & Eccles, 2000), and task specific beliefs influenced expectancy for success and task values (Wigfield & Eccles, 2000). The EVT incorporates beliefs about one's ability to accomplish a task successfully (e.g., self-efficacy) or beliefs about one's reasons for accomplishing a task (e.g., interest) (Perez, Cromley, & Kaplan, 2014), both of which are associated with academic achievement and choice (see Wigfield & Eccles, 2000; Eccles & Wigfield, 2002; Wigfield, Tonks, & Klauda, 2009). Therefore, we use the EVT, derived from Eccles et al. (1983), Wigfield (1994), and Wigfield and Eccles (2000), as the primary achievement motivation framework for this study to examine college engineering students' choices (to take more engineering courses, delay, missing deadlines), effort and persistence in engineering coursework, and continuation in the field of engineering. More specifically, the study seeks to investigate the relationships among the broader cultural milieu (such as gender stereotype threat and racial stereotype threat), achievement related beliefs (including task-specific beliefs, such as engineering self-efficacy), expectancy for academic success in engineering, engineering task values, and achievement behaviors (including choices, effort, persistence, and continuation in the field of engineering).

Figure 1 presents the model that depicts the hypothesized relationships among the variables of this study. We examined the relationships among college engineering students' perceptions, expectancy for academic success in engineering, engineering task values, and achievement behaviors in order to pursue the six research questions stated at the end of Chapter 1. The major relationships investigated in this research are represented by the five arrows in Figure 1, including: (1) how college engineering students' perceptions (engineering self-efficacy, gender stereotype threat, and racial stereotype threat) relate to expectancy for academic success in engineering; (2) how college engineering students' perceptions link to engineering task values (attainment value, intrinsic value, utility value, and cost); (3) how college engineering students' perceptions predict student achievement behaviors (choice to take more engineering courses, delay, missing deadlines, effort and persistence in engineering coursework, and continuation in the field of engineering); (4) how expectancy for academic success in engineering relate to student achievement behaviors; and (5) how engineering task values link to student achievement behaviors.

Expectancy for success and task values. According to Eccles et al.'s (1983) model, choices are directly affected by individuals' expectancy for success in a task and perceived task values. Expectancy for success was defined as individuals' beliefs about how well they would perform on upcoming tasks in the future (Eccles et al., 1983).

Research found that although girls showed lower expectancy for success than boys (Schreiner, Henriksen, Sjaastad, Jensen & Løken, 2010), boys and girls performed similarly in STEM tests (Hyde & Linn, 2006), indicating that boys' and girls' expectancy differences in STEM choices may not be explained by their academic performance.

Subjective task value, referring to the reasons for performing a task (Eccles & Wigfield, 2002), plays an important role in the model. It is conceptualized in terms of four components: attainment value, intrinsic value, utility value, and cost (Wigfield & Eccles, 2000). Attainment value is the importance of doing well on a task and intrinsic value refers to how interesting it is to engage in a task (Wigfield & Eccles, 2000). Utility value refers to how useful a task is in achieving an individual's long-term and short-term goals and cost is the emotional cost of engaging in one task, how much effort needed to accomplish the task, and how the decision to engage in this task restricts access to other tasks (Wigfield & Eccles, 2000). Research has indicated that intrinsic value and utility value play an important role in adolescents' academic development (e.g., Chiu & Wang, 2008; Plante, O'Keefe, & Théorêt, 2013; Steinmayr & Spinath, 2009). The four task value components have relatively high inter-correlations and are sometimes incorporated into a single and general task value scale (e.g., Eccles et al., 1983).

Research findings emphasized the importance of understanding the effect of expectancy for success and task values on students' achievement outcomes (Wigfield, 1994). The EVT predicted that the higher levels of expectancy for success, attainment value, intrinsic value, and utility value, the higher the possibility of engaging in a task, whereas the greater cost led to reduced probability of engaging in a task (Jensen & Sjaastad, 2013). Previous studies provided evidence that the EVT linked expectancy for success and subjective task values to performance and choice and provided a comprehensive theoretical framework for exploring STEM participation (Jensen & Sjaastad, 2013). For example, research found that students' expectancy for success in math strongly predicted their math grades and students' perceived values of math strongly predicted their choice to take more math courses and their enrollment in advanced math courses in high school (see Eccles, 1984a, b; Eccles et al., 1983; Eccles, Adler, & Meece, 1984; Ethington, 1991; Meece, Wigfield, & Eccles, 1990). Wigfield (1994) suggested that the relationship between expectancy for success and achievement performance would become stronger during the early years of school for students who viewed ability as capacity and become weaker for students who believed increased effort could improve ability. For the latter group of students, task values may become a stronger predictor of performance than expectancy for success (Dweck & Leggtt, 1988). Wigfield and Eccles (1989) found that both interest and usefulness of math are predictors of choice to take more math courses in high school and interest in math was the strongest predictor. Whereas most previous research testing the EVT has been conducted with students in 5th to 12th grade (Wigfield, 1994), a limited number of studies focused on college students and even fewer focused on college engineering students. In addition, many researchers examined task values either by excluding cost (e.g., Bong, 2001a; Chow et al., 2012) or combining it with other value components into a composite score (e.g., Buehl & Alexander, 2005; Sullins et al., 1995). Battle and Wigfield (2003) measured cost separately and found that cost negatively predicted academic choice. Therefore, one of the objectives of the current study was to examine the potential predictors of college engineering students' choices, effort, persistence, and continuation, such as expectancy for success and four task value components under the umbrella of the EVT.

Self-efficacy. Although the EVT model is composed of several important motivational factors, we focus on three prominent views: expectancy for success, subjective task values, and ability beliefs. An individual's belief in one's competence to produce desired results is commonly known as self-efficacy, which plays a prominent role in various motivation theories (Bandura, 1997; Wigfield & Eccles, 2000). A good deal of empirical research indicated that self-efficacy is a powerful predictor of achievement related outcomes such as academic achievement (Britner & Pajares, 2006; Wolters, Fan & Daugherty, 2013), grades in school (Caprara, Vecchione, Alessandri, Gerbino, & Barbaranelli, 2011), intention or behavior of dropping out of school (Alivernini & Lucidi, 2011; Fan & Wolters, 2014), cognitive strategy use (Pajares, 1996), metacognitive strategy use (Wolters et al., 2013), intention to enroll in courses (Lent et al. 1993), effort and persistence (Wolters et al., 2013).

Self-efficacy is an extensively-studied construct showing important influence in the field of educational psychology. According to social cognitive theory, individuals are more likely to accomplish tasks they believe they are more competent in and less likely to perform tasks they believe they are less competent in (Zeldin, Britner, & Pajares, 2008). People' perceptions of their self-efficacy are powerful predictors of their choices to perform a specific task and the effort and persistence they put forth in that task (Zeldin et al, 2008). Previous studies demonstrated a link between academic self-efficacy and academic achievement in different student samples. For example, primary and secondary school students' academic self-efficacy was positively correlated with their academic achievement (Tan, Peng, & Zhong, 2013) and high school students' academic self-efficacy predicted their academic achievement (Høigaard et al., 2014). Self-efficacy is also a predictor of undergraduate students' GPA (Komarraju & Nadler, 2013).

In relations with expectancy for success. Wigfield (1994) suggested that individuals' self-schemata and task-specific beliefs might be related to their expectancy for success and task values. Self-efficacy is a typical example of task-specific belief and it was found to be related to expectancy for success in previous empirical research (e.g. Chiu & Wang, 2008; Öcal & Aydin, 2009; Riggs & Knight, 1994). Computer self-efficacy predicted effort expectancy among part-time students who took Web-based courses in Taiwan (Chiu &Wang, 2008). Öcal and Aydin (2009) found that sports players' collective efficacy beliefs significantly predicted their future achievement expectations. Riggs and Knight (1994) found that personal efficacy predicted personal outcome expectancy and collective efficacy predicted collective outcome expectancy among university and state service employees.

In relations with task values. Researchers found that self-efficacy was significantly positively correlated with task values (Sungur, 2007; Lau et al., 2008; Lawanto, Santoso, & Liu, 2012; Alkharusi, Aldhafri, Alnabhani, & Alkalbani, 2013). Self-efficacy for learning performance was positively related to task value among 9-12th graders who participated in a Principles of Engineering class (Lawanto et al., 2012). Self-efficacy and task value were also significantly positively related among Oman students (Alkharusi et al., 2013) and Singaporean 9th graders' (Lau et al., 2008). High school students' self-efficacy for learning and performance was positively related to their task value (Sungur, 2007).

Stereotype threat. According to Eccles et al. (1983), Wigfield (1994), and

Wigfield and Eccles (2000), a broader cultural milieu in which student achievement behaviors occur includes gender stereotypes and cultural stereotypes of subject matter and occupational characteristics (Wigfield & Eccles, 2000). Stereotype threat was defined as the predicament in which members of disadvantaged groups (e.g., women in male-dominated fields, racial minorities) "must deal with the possibility of being judged or treated stereotypically, or of doing something that would confirm the stereotype" (Steele & Aronson, 1998, p. 401). This threat may increase anxiety and negatively influence performance (Chang, Eagan, Lin, & Hurtado, 2011). In the Experiment 1 of Steele and Aronson (1995), African-American students were administered a 30-minute test composed of items from the GRE Verbal test under one of three conditions of stereotype threat. Students in the stereotype threat condition were told that the test was diagnostic of their intellectual capability and these students solved fewer problems correctly compared with those in the control conditions (e.g., the test was described as a simple exercise). Since then, studies of stereotype threat on task performance have steadily increased. Other researchers also found similar findings when examining the effects of stereotype threat on African-Americans' academic performance (Osborne, 2001; Aronson, Fried, & Good, 2002). Negative effects of stereotype threat on Hispanics' academic performance have also been found (Gonzales, Blanton, & Williams, 2002).

Stereotype threat occurs across different domains and social groups. When group comparisons or group memberships were mentioned, the examples of the effects of stereotype threat included: 1) women performed worse than men on math tests (e.g., Spencer, Steele, & Guinn, 1999; Schmader, 2002; Schmader & Johns, 2003); 2) black students performed worse than white students when a test was introduced as a diagnosis of intellectual ability (Steele & Aronson, 1995; McKay, Doverspike, Bowen-Hilton, & Martin, 2002); 3) white students with low socioeconomic status performed worse than students from high socioeconomic status (Croizet & Claire, 1998); and 4) white men performed worse than Asian men on math tests (Aronson et al., 1999). There are two major types of stereotype threat: 1) gender stereotype threat, which refers to vulnerability to the threat posed by confirming gender stereotypes (Cromley et al., 2013); and 2) racial stereotype threat, which refers to vulnerability to the threat posed by confirming racial stereotypes (Cromley et al., 2013).

According to the statistics from the National Science Foundation (2009), females' engineering enrollment rate is 17.9% and URMs' engineering enrollment rate is 16.1%. Evidence showed that individuals perceived stereotypes based on gender or race in STEM fields (e.g., Blickenstaff, 2005; Chang et al., 2011; Espinosa, 2011; Fouad et al., 2010). Stereotypes may have a cumulative effect on individuals over time (Chang et al., 2011), which may be a reason why women and URMs are consistently underrepresented in the engineering field. Aronson (2004) found that even if students were previously identified with a field of study, being exposed to stereotype threat repeatedly could still lead to disidentification with the field of study. For example, when a negative stereotype about women and URMs in engineering becomes personally relevant (e.g. women will not become good engineers), women and URMs may be judged or treated in terms of the stereotype (e.g. professors expect lower grades from female engineering students) and thus, may reject any association with the engineering field as a way to protect self-esteem and to reduce anxiety related to confirming the stereotype (e.g. female engineering students do not care about becoming an engineer in the future). The whole stereotype threat process can result in decreased academic motivation and interest in pursuing the career (Chang et al., 2011). Therefore, stereotype threat may be a predictor of college engineering students' choices, effort, persistence, and continuation in the engineering field.

In relations with expectancy for success. According to EVT, individuals' achievement behaviors are determined by their expectancy for success and perceived task values, which in turn, rely on their contextual background as well as social influences (Wigfield & Eccles, 2000). Maass and Cadinu (2003) stated that stereotypes transmitted during socialization influenced children's self-schemata, goals, ability, beliefs, and expectancy for success. They assumed that stereotype threat might reduce minorities' expectancy for success on a task and the reduced expectancy might harm their performance. Stangor, Carr, and Kiang (1998) found that participants under stereotype threat showed consistent lower expectancy for success even though they had received positive feedback before. Smith (2006) also confirmed this stereotype threat effect and found that women were more likely to adopt performance-avoidance goals than men in a stereotype-related math context, and this goal adoption contributed to lower expectancy in math performance among women. An important direction for future research is to explore the associations among stereotypes, goals, expectancies, and actual performance (Smith, 2006).

In relations with task values. Researchers have found that individuals were more likely to be vulnerable to stereotype threat when they identified with a relevant domain strongly (e.g., Aronson et al., 1999; Spencer et al., 1999; Stone et al., 1999;

Cadinu et al., 2003). These studies suggest that people who consider a relevant domain important are likely to be at high risk for stereotype threat, whereas those less motivated are not as likely to be at high risk (Maass & Cadinu, 2003). The association between stereotype threat and perceived task values has not been examined explicitly and is examined in the current study.

The Choice to Take More Engineering Courses

Eccles et al. (1983) initially developed the EVT as a framework to understand adolescents' performance and choice in mathematics. Later development and applications of the theory have involved more achievement behaviors, including students' choice of activities and their effort and persistence in those activities (e.g. Matusovich et al., 2010). The achievement behaviors examined in this study include college engineering students' choices (take more engineering courses, delay, and miss deadlines), effort and persistence in engineering coursework, and continuation in the field of engineering.

According to Wolters (2004), the choice to take more engineering courses reflects students' attitudes about taking additional engineering-related courses in the future (in this study, in the future means in the upcoming semesters). One of the major constructs from the EVT included achievement behaviors such as students' choice (Wigfield, 1994). Eccles et al. (1983) proposed that students' choice of achievement tasks is predicted by their expectancy for success on these tasks and the subjective values they attach to these tasks. Most previous studies focused on students' choice of achievement tasks in mathematics; for example, researchers have addressed how students' expectancy for success and task values predicted their choice to take additional math courses (Wigfield, 1994). Wolters (2004) found that prior standardized achievement, gender, mastery orientation, performance-avoidance orientation, and self-efficacy were associated with college students' choice to take more mathematics courses in the future.

In relations with self-efficacy. Researchers have examined the relations between self-efficacy and students' choices to take more courses over the decades. Wolters (2004) found that self-efficacy predicted college students' choice to take more mathematics courses in the future. Artino (2010) also found that students who preferred to take online courses rather than face-to-face courses in the future reported higher self-efficacy in online learning and higher self-efficacy predicted the preference to take online courses in the future.

In relations with stereotype threat. The studies of stereotype threat's effect on students' choices of academic tasks in STEM are limited. Good (2001) found that elementary school girls' did not choose to work on difficult math problems under stereotype threat conditions. Deemer et al. (2014) also found that stereotype threat had a significant negative indirect effect on female students' career choice intentions in physics. Limited research has been done to examine the relationship between college engineering students' stereotype threat and their choice to take more engineering course and the current study contributes to the literature in this area.

In relations with expectancy for success and task values. Literature also indicates that students' perceived task values predicted their choice to take more mathematics courses (e.g. Eccles, 1984a, b; Eccles, Adler, & Meece, 1984; Meece et al., 1990). Eccles (1984a) and Eccles, Adler, and Meece (1984) found that 8th through 10th grade students' task values in mathematics were strong predictors of their choice to take advanced high school math courses. Eccles (1984b) found that 5th through 12th grade students' task values in mathematics were stronger predictors of their choice to take math courses than their expectancy for success. Meece et al. (1990) found that junior-high school students' perceived attainment value of mathematics was a stronger predictor of their choice to take more math courses than did their expectancy for success in math. Matusovich et al. (2010) conducted a qualitative study and found that value-related constructs predicted students' choices to earn engineering degrees. This study only included 11 participants and further study examining students' choice of achievement tasks in engineering using advanced quantitative analyses is warranted. Moreover, much fewer studies focused on the association between students' expectancy for success and choice to take more engineering courses. Therefore, the current study examined the relationships among college engineering students' expectancy for success in engineering, engineering task values, and choices to take more engineering courses using quantitative analyses from the perspective of the EVT.

The Choices to Delay and to Miss Deadlines

Students' choices to delay and to miss deadlines are referred to as academic procrastination in some studies. Similarly, academic procrastination may be understood as a personal choice in academic achievement, and choice is one of the several achievement outcomes that are related to expectancy for success and task values (Eccles et al., 1983). Procrastination has been defined as "purposive delay in the beginning and/or completion of an overt or covert act, typically accompanied by subjective discomfort" (Ferrari, 1998, p. 281) or "voluntarily delay an intended course of action despite expecting to be worse off for the delay" (Steel, 2007, p. 66). It is a widespread phenomenon consistently affecting adults in various life domains, such as workplace (e.g., Lonergan & Maher, 2000; Hammer & Ferrari 2002), everyday life routines and obligations (e.g., O'Donoghue & Rabin, 1999), health-related behaviors (Tice & Baumeister, 1997; Sirois, Melia-Gordon, & Pychyl, 2003), and leisure activities (Shu & Gneezy 2010). It is particularly prevalent in the academic domain where approximately 50% of college students reported consistently putting off academic tasks that they intend to accomplish to the point of having emotional discomfort, known as academic procrastination (Day, Mensink, & O'Sullivan, 2000; Solomon & Rothblum, 1984). Research has shown that students who procrastinate academically tend to receive significantly lower grades on term papers (Tice & Baumeister, 1997), lower grades on final exams and course assessments (Steel, Brothen, & Wambach, 2001), as well as lower college grade point averages (Wesley, 1994). Due to these negative outcomes in academic behaviors and achievement, academic procrastination as a critical problem in education has been studied from various perspectives in recent decades.

Researchers who focus on issues of student motivation argue that students fail to complete academic tasks on time primarily from the perspectives of self-regulation, goal orientation, self-determination, or attribution theory. Research using a self-regulation theory suggested that students who reported to plan, monitor, and regulate their use of strategies were less likely to report frequent procrastination even after accounting for differences in their motivational beliefs (e.g., Wolters, 2003). Research on goal orientation demonstrated a significant relation between students' work-avoidance goal orientation and procrastination showing that students who expressed a stronger preference for easy academic tasks were more likely to postpone getting started (Wolters, 2003). Research applying a self-determination perspective showed that procrastination was negatively associated with intrinsic motivation (Rakes & Dunn, 2010) and extrinsic motivation (Brownlow & Reasinger, 2000). Research utilizing the perspective of attribution suggested external attributional style and locus of control were related to academic procrastination (Brownlow & Reasinger, 2000). These findings are interesting and intriguing as they demonstrate that student procrastination is related to the dynamics of students' motivational process. However, there has been limited research looking into the relationship among procrastination, expectancy for success, and subjective task values from the EVT's perspective.

Steel and König (2006) made an early attempt to look at procrastination in the context of the EVT. Derived from this perspective, they proposed a motivational formulation taking into account various task-related components including expectancy and task value. This formulation indicates a value-related intervention showing that decreasing task value results in increasing procrastination (Steel, 2007). Though intriguing and persuasive, this assumption is not yet fully supported by empirical research until today. The question of whether and how task value is related to academic procrastination remains unclear. Another limitation of the above formulation is that task value was viewed as a single or combined measure while the construct is conceptualized and acknowledged as multi-dimensional and consisting of different components according to the EVT and empirical research (e.g., Wigfield & Eccles, 2000).

Due to the lack of research concerning students' academic procrastination from the perspective of the EVT, the current research sought to fill this gap by examining the connections among college engineering students' motivational factors (stereotype threat, expectancy for success in engineering, engineering task values, engineering self-efficacy) and academic achievement behaviors (choices, effort, persistence, continuation). Findings of the study can convey practical significance in developing procrastination interventions with an emphasis on promoting student school motivation in order to increase student effort, persistence, and continuation in the field of engineering.

In relations with self-efficacy. Literature has shown that there is a strong negative association between self-efficacy and procrastination (e.g., Van Eerde, 2003; Steel, 2007). Steel (2007) conducted a meta-analysis of procrastination based on 691 correlations and found strong evidence that procrastination was negatively correlated with self-efficacy. Similar results were supported by other meta-analytic reviews conducted by Van Eerde (2003). This relationship has been supported in various settings. For example, academic self-efficacy was negatively related to procrastination among college students in the United States (Haycock, McCarthy, & Skay, 1998; Katz, Eilot, & Nevo, 2014; Tuckman, 1991; Wolters, 2003), and college students in Canada and Singapore (Klassen et al., 2010). Researchers also found that self-efficacy for self-regulation had a strong relationship with procrastination in adolescents (Klassen et al., 2009) and Turkish high school students (Klassen and Kuzucu, 2009). Procrastination can result in bad performance and low self-efficacy, which lead to more procrastination (Steel, 2007). Self-efficacy fully mediated the association between self-oriented perfectionism and academic procrastination (Seo, 2008) and also mediated the effect of perceived goal achievement on procrastination (Wäschle, Allgaier, Lachner, Fink, & Nückles, 2014).

In relations with stereotype threat. Although the association between self-efficacy and procrastination was examined extensively, few studies have investigated how students' stereotype threat is related to academic procrastination. Deemer, Smith, Carroll, and Carpenter (2014) found that stereotype threat was a significant positive predictor of procrastination for students in STEM fields.

In relations with expectancy for success and task values. Though the relationship between self-efficacy and procrastination was extensively examined, few studies have investigated how students' expectancy for success and subjective task values are related to academic procrastination. Earlier research of relevance has consistently identified aversion to the task as a primary motivator of procrastination, showing that the reasons for procrastination can be that the task was unpleasant, boring, or uninteresting (see review Steel, 2007). For example, Pychyl and his colleagues (2000) examined affective correlates of procrastination through experience-sampling and revealed that students reported more procrastination when engaged in unpleasant, stressful and difficult tasks. Blunt and Pychyl (2000) showed that when students perceived their projects as boring, frustrating, stressful, unstructured or not meaningful, their procrastination behaviors were more likely to occur. Later research has moved to extend to the studies of task aversiveness to a variety of person-task characteristics. For example, Ackerman and Gross (2005) in the marketing education literature assessed how several aspects of task characteristics for a course influence the degree of procrastination on academic assignments. Their MANCOVA analyses comparing low-procrastination and high-procrastination groups showed that students' interest toward assignments had a significant effect on procrastination. Cao (2012) also found that procrastinators reported low task values. In sum, research has generally agreed that students' perceptions of academic tasks play an important role in their procrastination behaviors, which can lead to student school success. Yet, how the different components of subjective task values such as attainment value and cost relate to academic procrastination remains unclear. Steel (2007) proposed that the higher a student's expectancy for success, the less likely the student would procrastinate. However, there is a lack of empirical research examining the association between expectancy for success and academic procrastination.

Effort, Persistence, and Continuation

The present study also investigated three different aspects of student academic engagement in school activities, namely effort, persistence, and continuation. Effort refers to students' beliefs that they worked hard to complete their academic tasks, and persistence refers to students' beliefs that they completed their academic tasks even when they faced distractions, boredom, or difficulty (Wolters, 2004). Continuation in the field refers to an interest in graduate study in the field, an interest in having a career in the field, and the intent to persist in a major (Schmader, Johns, & Barquissau, 2004). Understanding student engagement in school activities is imperative given the evidence suggesting that greater level of student engagement is significantly associated with various student outcomes including academic achievement and performance (Furrer & Skinner, 2003), course enrollment intentions (Meece, Wigfield, & Eccles, 1990) and school dropout (Finn & Rock, 1997). Moreover, it draws increasing attention due to its nature of being malleable and adaptive to contextual features (Fan & Williams, 2010) and personal beliefs and goals (Wolters, 2004).

In relations with self-efficacy. The EVT model proposes that students' achievement-related choice, behavior, and persistence can be explained by their ability belief, task-specific expectancy and subjective task values. Prior research has demonstrated that self-efficacy and task values are good predictors of effort and persistence (Chouinard, Karsenti, & Roy, 2007; Cox & Whaley, 2004; Fan, 2011). Research has established a positive relationship between students' self-efficacy and academic engagement (e.g., Fan, 2011; Marra, Rodgers, Shen, & Bogue, 2009; Restubog, Florentino, & Garcia, 2010; Zeldin et al, 2008). That is, students with high self-efficacy are more likely to participate and persist in academic tasks and put forth greater effort, and these behaviors enhance learning consequently. Research has demonstrated the effect of self-efficacy on effort in various samples and settings. For example, people's perceptions of their self-efficacy predicted their effort on the task (Zeldin et al, 2008).

Previous studies have also examined the effect of self-efficacy on persistence in academic and non-academic settings. Researchers found that mothers' self-efficacy in self-regulation was positively related to their persistence towards exercise goals (Jung & Brawley, 2011). People' perceptions of their self-efficacy predicted their persistence in the task (Zeldin et al, 2008). In general, higher self-efficacy was associated with greater persistence (Restubog et al., 2010). Marra et al. (2009) studied female engineering students' engineering self-efficacy for two years at five U.S. institutions. They found that engineering self-efficacy was positively correlated with female students' persistence in engineering. Jones et al. (2010) also investigated college students' engineering self-efficacy and found that engineering self-efficacy was a better predictor of achievement in engineering than the value-related constructs (attainment value, intrinsic value, and utility value). The relationship between engineering self-efficacy and continuation in the field of engineering has not been studied in previous research and is examined in the current research.

In relations with stereotype threat. Among all STEM subjects, the effect of stereotype threat on math performance in K-12 or college settings have been studied extensively (e.g. Good, Aronson, & Harder, 2008; Lesko & Corpus, 2006; Martens, Johns, Greenburg, & Schimel, 2006; O'Brien & Crandall, 2003; Schemader, 2002; Spencer, Steel, & Quinn, 1999). A good number of studies also focused on the effect of stereotype threat on STEM engagement. Steele et al. (2002) found that women in STEM had the highest possibility to report thinking about changing their major, which indicates that women in STEM have low persistence in their majors. Deemer, Thoman, Chase, and Smith (2014) found that stereotype threat had a significant negative indirect effect on female students' continuation in a physics career.

The effect of stereotype threat on engineering performance has not been studied as extensively. Bell, Spencer, Iserman, and Logel (2003) found that women performed worse than men on a short version of the Fundamental of Engineering Exam when stereotype threat was high. They also found that women and men performed equally well on the engineering exam when stereotype threat was diminished. In a longitudinal study, Felder, Felder, Mauney, Hamrin, and Dietz (1995) found that on average, female students had credentials equal to or better than those of male students when entering chemical engineering and showed erosion in confidence and academic performance later on. One of the explanations from the researchers is that instructors and advisors may discriminate against female students. The effect of stereotype threat on effort, persistence, and continuation has not been studied in the context of engineering and the current study examined these relationships (see arrow 3 in Figure 1).

In relations with expectancy for success and task values. Eccles et al. (1983) proposed that individuals' expectancy for success on tasks and the subjective value of the tasks were most likely to be associated with their achievement performance, effort, and persistence of achievement tasks. These proposed relationships have been supported in empirical research. Research has indicated that students' subjective task value is significantly related to their effort in online courses (Yang, Cho, Mathew, & Worth, 2011), effort in homework performance (Trautwein & Ludtke, 2007), effort in mathematics class (Greene, DeBacker, Ravindran, & Krows, 1999), and engagement in science activities and intentions of pursuing careers in science (Nagengast et al., 2011). Students' expectancy for success was related to their subsequent math grades, whereas their perceived task value was associated with math enrollment intentions (Meece, Wigfield, & Eccles, 1990). Trautwein et al. (2012) found that expectancy for success and task values (attainment value, intrinsic value, utility value, and cost) predicted achievement when they were entered separately into a regression model for secondary school students. Expectations to go to college had a positive effect on American high school students' effort (Domina, Conley, & Farkas, 2011) and task value was positively related to student effort in online courses (Yang, Cho, Mathew, & Worth, 2011). Cox and Whaley (2004) found that expectancy for success was positively related to effort and persistence. Expectancy for success (science self-concept), task value (enjoyment of science), and the Expectancy × Value interaction were positively related to engagement in science activities and continuation in science careers (Nagengast et al., 2011). With previous limitations in mind, the current study aims to explore (1) the relationship between expectancy for academic success in engineering and achievement behaviors (arrow 4 in Figure 1) and (2) the relationship between task values and achievement behaviors (arrow 5 in Figure 1).

Chapter III

Method

Participants and Setting

A total number of 163 undergraduate engineering students enrolled in a large southern urban university with a diverse student body participated in the study. The sample included 43 women (26.4%) and 119 men (73.6%), aged between 18 and 40 years old (M = 20.76, SD = 3.45). The majority (92%) of the students were between 18 and 24 years old. There were 50 students (30.7%) who identified themselves as Asian/Pacific Islander, 42 (25.8%) as Caucasian, 38 (23.3%) as Hispanic, 17 (10.4%) as African American, and 13 (8.0%) as multi-racial. A total number of 122 (74.9%) participants reported a Major GPA of 3.0 or above. Participants consented and completed a paper-and-pencil survey in their engineering classes. Classes included two freshman classes in electrical and computer engineering, one freshman honors class in electrical and computer engineering, and one junior class in mechanical engineering. The university institutional review board approved all procedures.

Measures

The survey consisted of measures on students' perceptions (academic self-efficacy, gender stereotype threat, and racial stereotype threat), expectancy for academic success in engineering, engineering task values (attainment value, intrinsic value, utility value, and cost), and achievement behaviors (delay, missing deadlines, choice, effort, persistence, and continuation). All the measures adopted a 5-point Likert-type scale format ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Gender, ethnicity, academic level, and self-reported GPA were included in the study as control variables.

For gender, females were coded as “0” and males were coded as “1”. For ethnicity, Asian/Pacific Islander and Caucasian/White were coded as “0” and underrepresented minorities (Native American/American Indian, Black/African American, Hispanic/Latino, multi-racial, and other) were coded as “1”. In the academic level question, participants chose their class standing at the university. The question of self-reported GPA asked participants to choose their major GPA as the start of spring 2014 from five categories ranging from 1 to 5: 1.99 or lower, 2.0-2.49, 2.5-2.99, 3.0-3.49, and 3.5 or higher. More details about the demographic questions 1-12 can be found in Appendix A. In questions 13-83 of Appendix A, participants read a short statement and indicated how strongly they agreed or disagreed with the statement.

Stereotype threat. The researcher adopted a stereotype threat measure of vulnerability to race and gender stereotype bias from Cromley et al. (2013). The original measure tapped vulnerability to the threat by confirming gender and racial stereotypes with Cronbach alpha ranging from .86 to .92 across different time points (Cromley et al., 2013). The researcher modified the original 10-item measure and emphasized stereotype threat in engineering contexts. A sample item of gender stereotype threat is “I believe that my ability to perform well on engineering tests is affected by my gender” (See questions 13-17 in Appendix A). The internal reliability coefficient of the gender stereotype threat scale was .87. A sample item of racial stereotype threat is “I believe that my ability to perform well on engineering tests is affected by my race” (See questions 18-22 in Appendix A). The internal reliability coefficient of the racial stereotype threat scale was .90.

Expectancy for academic success in engineering. The researcher created the

Expectancy for Academic Success in Engineering Scale by adjusting (questions 23, 24, 25, 26, 27, 28, 29, 30, 31, and 32) and creating (questions 33, 34, and 35) items based on the modified version of the Revised Generalized Expectancy for Success Scale (R-GESS) (Hale, Fiedler, & Cochran, 1992). There are 25 items in Hale et al.'s (1992) scale, which is comprehensive and covers many aspects with a split-half reliability coefficient of .92, however, some items are not related to academics (e.g., In the future, I expect that I will reach my financial goals). Therefore, the researcher created three items and selected 10 items from R-GESS and modified them to specifically measuring academic contexts in engineering. For example, an original item is "In the future I expect that I will have successful close personal relationships" and the researcher modified it as "In the future, I expect I will have successful academic relationships with my engineering professors."

The factorability of the 13 items was examined. Several well-recognized criteria for the factorability were used. The Kaiser-Meyer Olkin (KMO) measure of sampling adequacy was used to test if the variables were too highly correlated to distinguish between them (Hinton, Brownlow, McMurray, & Cozens, 2004). The KMO was .906, which is above the value of .5, suggesting a satisfactory factor analysis (Hinton et al., 2004). The Bartlett's test of sphericity was assessed to find whether there was a relationship between the variables (Hinton et al., 2004). The result was χ^2 (78) = 1577.05, $p < .001$. Given these criteria, principle component analysis (PCA) was deemed to be suitable with all 13 items.

PCA was conducted to identify the factors underlying the Expectancy for Academic Success in Engineering Scale. A three-factor solution was supported by the data (Table 1). The initial eigenvalues indicated that the first three factors had eigenvalues greater than one explaining 55%, 10%, and 9% of the variance, respectively. Varimax rotation was conducted and all of the items in the PCA had primary loadings over .7. The communalities were all above .63 indicating that more than 63% of the variability in each item was explained by the three factors (Hinton et al., 2004). The 13 items were grouped into 3 factors. Seven items loaded onto Factor 1 and they focused on students' reported expectancy in successfully completing engineering academic tasks and solving engineering academic problems, which was named *Expectancy for Completion of Engineering Academic Tasks*. Three items loaded onto Factor 2, and they are related to the students' expectancy for obtaining an engineering degree and completing undergraduate engineering education. Factor 2 was named *Expectancy for Completion of Engineering Education*. Three items loaded onto Factor 3 and they focused on students' reported expectancy in engineering classroom interaction and recognition, as well as relationships with classmates and professors. Factor 3 was named *Expectancy for Successful Engineering Academic Relationships*. These three factors were in line with our hypothesis. Internal consistency for each factor was examined using Cronbach's alpha. Analyses of the internal consistency yielded satisfactory results with adequate Cronbach's alpha of .75 for *Expectancy for Successful Engineering Academic Relationships* (a sample item is: "In the future, I expect I will have successful academic relationships with my engineering professors", see questions 23-25 in Appendix A), .94 for *Expectancy for Completion of Engineering Academic Tasks* (a sample item is "In the future, I expect I will succeed at most engineering academic tasks I try", see questions 26-32 in Appendix A), and .89 for *Expectancy for Completion of Engineering Education* (a sample item is "In the future, I expect I will graduate with an engineering degree", see questions 33-35 in Appendix A).

Engineering Task values. According to Eccles et al. (1983)'s EVT model, task values were measured by four components: attainment value, intrinsic value, utility value, and cost. Items assessing the four components were primarily adopted from Trautwein et al. (2012) and Battle and Wigfield (2003). Trautwein et al. (2012) used 12 items to measured students' task values in mathematics and English with internal consistency ranging from .75 to .90. Battle and Wigfield (2003) used 51 items to measure students' value of education with Cronbach alpha ranging from .76 to .96. The wording of the items from Trautwein et al. (2012) was modified specifically to refer to academic contexts in engineering and that from Battle and Wigfield (2003) was modified specifically to refer to the value of academics for the current study in engineering. The researcher created one item to measure cost (question 50), adapted 10 items (questions 36, 37, 38, 39, 40, 41, 44, 45, 48, and 49) from Trautwein et al. (2012) to measure all four components, and adapted four items (questions 42, 43, 46, and 47) from Battle and Wigfield (2003) to measure three components except for attainment value. The original items in Trautwein (2012) focused on task values in mathematics and English, therefore, the wording was revised to specifically referring to academic contexts in engineering (e.g. "mathematics/English" was revised to "engineering" in questions 36, 37, 39, 40, 41, 44, 45, 48, and 49; "mathematician/good at English" was revised to "engineering student" in question 38). The original items in Battle and Wigfield (2003) focused on the value of graduate school education, therefore, the statements were revised to specifically referring to the value of undergraduate education in engineering (e.g. "engineering" was added and "in graduate school" were deleted in question 42; "graduate school" was revised to “my engineering classes” in question 43; “graduate degree” was revised to “engineering classes” in question 46 and “bachelor’s degree in engineering” in question 47). The Engineering Task Value scale was adjusted to fit the Eccles et al. (1983) EVT model and included 15 items covering all four components of task value (3 items in attainment value, 5 items in intrinsic value, 4 items in utility value, and 3 items in cost). Cost items were not reverse-coded; therefore, higher value indicates more limitations of doing other activities when focusing on one activity, more efforts needed to complete the activity, and higher emotional cost. A sample item of attainment value is: ‘‘I’m really keen to learn a lot in my engineering classes” (see questions 36-38 in Appendix A). A sample item of intrinsic value is: ‘‘I like attending stimulating engineering lectures” (see questions 39-43 in Appendix A). A sample item of utility value is: ‘‘Good grades in my engineering courses can be of great value to me later” (see questions 44-47 in Appendix A). A sample item of cost is: ‘‘I’d have to sacrifice a lot of free time to be good at my engineering schoolwork” (see questions 48-50 in Appendix A). The Cronbach’s alphas of attainment value, intrinsic value, utility value, and cost were .83, .78, .73, and .89, respectively.

Engineering self-efficacy. The researcher adapted and adjusted an existing quantitative scale from Pintrich et al. (1993) to measure engineering self-efficacy. The scale included five items, which reflected how confident the participants were in their ability to successfully learn the material, master the skills taught, and do well on tests and assignments in engineering courses (Wolters, 2012, under review). The original scale has a Cronbach alpha of .87 (Wolters, 2012, under review). The original items focused on self-efficacy in general; therefore, the researcher adapted these items by emphasizing self-efficacy in engineering contexts. For example, an original item "I am confident I can do an excellent job on the assignments and tests in my courses" was modified to "I am confident I can do an excellent job on the assignments and tests in my engineering courses" (see questions 51-55 for all five items in Appendix A). The Cronbach's alpha was .88.

Delay and missing deadlines. Items adapted from a modified version of the Pure Procrastination Scale (PPS, Steel, 2010) were used to assess two aspects of student procrastination: delay and missing deadlines. The original PPS has a Cronbach alpha of .92. The modified procrastination measure consisted of 12 items tapping into students' tendency to put off responsibilities and miss deadlines, as well as delay the decision-making needed to complete important engineering tasks. The statements were modified slightly to refer specifically to engineering contexts. For example, "I waste a lot of time on trivial matters before getting to any final decisions about my schoolwork" was modified to "I waste a lot of time on trivial matters before getting to any final decisions about my engineering tasks."

The factorability of the 12 items was examined. Several well-recognized criteria for the factorability were used. The Kaiser-Meyer Olkin (KMO) measure of sampling adequacy was used to test if the variables were too highly correlated to distinguish between them (Hinton, Brownlow, McMurray, & Cozens, 2004). The KMO was .895, which is above the value of .5, suggesting a satisfactory factor analysis (Hinton et al., 2004). The Bartlett's test of sphericity was assessed to find whether there was a relationship between the variables (Hinton et al., 2004). The result was χ^2 (66) = 1106.70, $p < .001$. Given these criteria, principle component analysis (PCA) was deemed to be suitable with all 12 items.

PCA was conducted to identify the factors underlying the Pure Procrastination Scale. A two-factor solution was supported by the data (Table 2). The initial eigenvalues indicated that the first two factors had eigenvalues greater than one explaining 52% and 10% of the variance, respectively. Varimax rotation was conducted and all of the items in the PCA had primary loadings over .47. The communalities were all above .37 indicating that more than 37% of the variability in each item was explained by the two factors (Hinton et al., 2004). The 12 items were grouped into two factors. Eight items loaded onto Factor 1 and they focused on students' tendency to put off responsibilities and delay the decision-making needed to complete important tasks, which was named *Delay*. Four items loaded onto Factor 2, and they are related to the students' tendency to miss deadlines. Factor 2 was named *Missing Deadlines*. These two factors were in line with our hypothesis. Internal consistency for each factor was examined using Cronbach's alpha. Analyses of the internal consistency yielded satisfactory results with adequate Cronbach's alpha of .91 for *Delay* (a sample item is: "I generally delay before starting engineering work I have to do", see questions 56-63 in Appendix A) and .74 for *Missing Deadlines* (a sample item is "I don't get engineering tasks done on time", see questions 64-67 in Appendix A).

Choice, effort, & persistence. Items for choice, effort, and persistence measures were adapted from Wolters (2004)'s Motivational Engagement Instrument to fit in academic contexts in engineering. The original choice, effort, and persistence scales had Cronbach alpha of .79, .74, and .73, respectively. The researcher changed the word "math" to "engineering" in all four items for each measure. The choice to take more engineering courses measure included four items (α = .78) assessing students' belief that they would choose to take more engineering courses in the future. A sample item is: "I look forward to taking more engineering courses in the future" (see questions 68-71 in Appendix A). The effort in engineering coursework measure included four items (α = .79) assessing students' belief that they worked hard to complete tasks for their engineering classes. A sample item is: "I always work as hard as I can to finish my engineering assignments" (see questions 72-75 in Appendix A). The persistence in engineering coursework measure included four items (α = .74) reflecting students' beliefs that they completed work for their engineering classes even when faced with distractions, boredom, or difficulty. A sample item is: "I get distracted very easily when I am studying for engineering" (see questions 76-79 in Appendix A).

Continuation in the field of engineering. Continuation in the field of engineering was measured by a modified scale with four items reflecting students' beliefs about their interest in graduate study in the field of engineering, interest of having a career in the field of engineering, and intent to persist in a major. The original measure developed by Schemader et al. (2004) assesses students' beliefs about their interest in graduate study related to their major, interest of having a career in mathematics or science, and intent to change their major. The researcher adapted the original measure for use in academic contexts in engineering and changed the questions to statements. For example, an original item is "How likely is it that you will pursue graduate study related to your major", which was modified as "I will pursue graduate study in engineering" (see questions 80-83 in Appendix A). The Cronbach's alpha was .66.

Procedure

The researcher obtained approval from the University Committee for Protection of Human Subjects and obtained approvals from four professors from the College of Engineering to distribute a paper-and-pencil survey in their engineering classrooms. The researcher scheduled a date and time with the professors and printed enough copies of the survey (see Appendix A) and the cover letter (Appendix B) before going to the classrooms. After arriving in the classrooms, the researcher introduced herself and gave a brief description of the study (see Appendix C). Students were given a copy of the cover letter and a copy of the survey. After students read the cover letter and agreed to participate in the study, they completed the survey in class and returned the survey to the researcher. The data were input and saved on a secure computer. The final data files will be kept in the office computer of the researcher's advisor for three years.

Data Analysis

The SPSS statistical analysis package was used to conduct all statistical analyses. Data were first screened for outliers and missing data were imputed by mean imputation method due to low rate of missing data. Mean imputation refers to replacing missing values on a variable with the mean of that variable. Principle component analysis of the Expectancy for Academic Success in Engineering Scale and the Pure Procrastination Scale were conducted. Mean, standard deviation, frequency, and reliability of each variable were computed afterwards. Correlations were computed to determine the associations among the variables. Multiple hierarchical regressions were conducted to determine the relationships among all the variables, and the predictors of college engineering students' delay, missing deadlines, choice to take more engineering courses, effort and persistence in engineering coursework, and continuation in the field of engineering.

Chapter IV

Results

Results are presented in three sections. Descriptive information regarding each variable in the study is presented. Bivariate relations are evaluated between the independent variables (gender stereotype threat, racial stereotype threat, expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, and expectancy for completion of engineering education, attainment value, intrinsic value, utility value, cost, engineering self-efficacy) and dependent variables (delay, missing deadlines, the choice to take more engineering courses, effort, persistence, and continuation). Lastly, multiple hierarchical regressions are conducted to learn more about the relations among each variable and the predictors of each dependent variable.

Descriptive Results

Table 3 presents the mean, standard deviation, and reliability for each variable measured in this study. All the items were measured by 5-point Likert scales, with values ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Results indicated a general positive endorsement of expectancy for academic success, task values, engineering self-efficacy, choice, effort, persistence, and continuation in the field of engineering. In general, participants reported that they did not agree that they had experienced gender stereotype threat (M = 1.61, SD = .72) or racial stereotype threat (M = 1.68, SD = .77) in their engineering classrooms. They reported that they did not tend to delay (M = 2.95, SD = .88) or miss deadlines (M = 2.55, SD = .81). Most measures demonstrated a satisfactory reliability ($a \geq .73$), except the continuation in the field of engineering measure (*a* = .66).

Bivariate Analyses

Pearson correlations are shown in Table 4. As expected, students with lower gender stereotype threat were more likely to expect that they would complete their engineering education ($r = -.16$, $p < .05$) and students with lower racial stereotype threat were more likely to find their engineering tasks interesting ($r = -.17$, $p < .05$) and useful ($r = -.16$, $p < .05$). In addition, students with higher engineering self-efficacy were more likely to show higher levels of expectancy for successful engineering academic relationships ($r = .40$, $p < .01$), expectancy for completion of engineering academic tasks ($r = .70$, $p < .01$), and expectancy for completion of engineering education ($r = .49$, $p < .01$). Students with higher engineering self-efficacy were also more likely to view their engineering tasks as important ($r = .57$, $p < .01$), interesting ($r = .60$, $p < .01$), and useful ($r = .46$, $p < .01$). These correlations were hypothesized and identified as numbers 1 and 2 in Figure 1.

According to Table 4, Pearson correlations indicated that students with higher engineering self-efficacy were less likely to report tendency to delay making decisions and/or completing the task itself ($r = -.35$, $p < .01$) and to miss deadlines ($r = -.30$, $p < .01$). Students with higher engineering self-efficacy were also more likely to choose to take more engineering courses in the future ($r = .41$, $p < .01$), put forth effort in their engineering tasks ($r = .37$, $p < .01$), persist in their engineering tasks ($r = .41$, $p < .01$), and continue in the field of engineering ($r = .47$, $p < .01$). Results also showed that students with lower levels of gender stereotype threat ($r = -.18$, $p < .05$) and racial stereotype threat ($r = -.23$, $p < .01$) were more likely to choose to take more engineering courses in the future. Students with lower levels of racial stereotype threat were more likely to persist in their engineering tasks ($r = -.16$, $p < .05$) and continue in the field of engineering ($r = -.18$, $p < .05$). These correlations were hypothesized and identified as number 3 in Figure 1.

Results showed that students with higher levels of expectancy for successful academic relationships, expectancy for completion of academic tasks, and expectancy for completion of education were less likely to report tendency to delay making decisions and/or doing task itself (with correlations ranging from -.34 to -.24, $p < .01$) and to miss deadlines (with correlations ranging from -.28 to -.22, $p < .01$). Students with higher levels of expectancies were also more likely to choose to take more engineering courses in the future (with correlations ranging from .38 to .47, $p < .01$), put forth effort in their engineering tasks (with correlations ranging from .41 to .46, $p < .01$), persist in their engineering tasks (with correlations ranging from .32 to .45, $p < .01$), and continue in the field of engineering (with correlations ranging from .42 to .64, $p < .01$). These correlations were hypothesized and identified as number 4 in Figure 1.

Results also indicated that students who perceived higher levels of attainment value, intrinsic value, and utility value of their engineering tasks were more likely to choose to take more engineering courses in the future (with correlations ranging from .52 to .63, $p < .01$), put forth effort in their engineering tasks (with correlations ranging from .35 to .52, $p < .01$), persist in their engineering tasks (with correlations ranging from .39 to .45, $p < .01$), and continue in the field of engineering (with correlations ranging from .47 to .53, $p < .01$). In addition, students who perceived higher cost of their engineering tasks were more likely to put forth effort in their engineering tasks ($r = .19$, $p < .05$).

These correlations were hypothesized and identified as number 5 in Figure 1.

Hierarchical Regressions Predicting Achievement Behaviors

Multiple hierarchical regressions were conducted to further examine which variables contribute to the variances of students' achievement behaviors, including choices, effort, persistence, and continuation. By examining the correlation coefficients in Table 4, we found that engineering self-efficacy and expectancy for completion of engineering academic tasks were highly related ($r = .70$, $p < .01$). In addition, gender stereotype threat and racial stereotype threat were highly related ($r = .69$, $p < .01$). The high correlation coefficients indicate that these variables are very similar and multicollinearity may exist. In order to avoid the problem of multicollinearity and examine the effect of expectancies on students' choices, effort, persistence, and continuation, we conducted hierarchical regressions by removing engineering self-efficacy as a predictor and combining gender stereotype threat and racial stereotype threat as one variable named *stereotype threat* when running hierarchical regressions (see Table 5). Therefore, independent variables (e.g., stereotype threat, expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, expectancy for completion of engineering education, attainment value, intrinsic value, utility value, and cost) and control variables (e.g. gender, ethnicity, academic level, and self-reported GPA) were entered in the model to predict college engineering students' delay, missing deadlines, the choice to take more engineering courses, effort, persistence, and continuation.

The possibility that multicollinearity among the predictors substantially influenced these results was evaluated. "Tolerance is an indicator of how much of the variability of the specified independent is not explained by the other independent variables in the model and is calculated using the formula 1-R squared for each variable. If this value is very small (less than .10) it indicates that the multiple correlation with other variables is high, suggesting the possibility of multicollinearity. The other value given is the VIF (Variance inflation factor), which is just the inverse of the Tolerance value (1 divided by Tolerance). VIF values above 10 would be a concern here, indicating multicollinearity" (Pallant, 2010, p. 158). According to the output of SPSS multiple hierarchical regressions, all Tolerance values are above .33 and all VIF values are less than 3.06, therefore, multicollinearity may be ignored at this time.

Results from the hierarchical regressions predicting students' achievement behaviors, including choices, effort, persistence, and continuation are presented in Table 5. All control variables (e.g. gender, minority, academic level, and self-reported GPA) were entered in Step 1. They accounted for 9% of the variance in delay, $F(4, 158) = 3.90$, $p < .01$ and 8% of the variance in persistence, $F(4, 158) = 3.90$, $p < .05$. Gender and minority were not significant predictors of any of the achievement behaviors. Students with higher academic level were less likely to delay ($\beta = -.26$, $p < .01$) and more likely to put forth effort to complete their engineering tasks ($\beta = .21$, $p < .05$) and persist in their engineering tasks ($\beta = .19$, $p < .05$). Students with higher self-reported GPA were less likely to delay ($\beta = -.22$, $p < .01$) and miss deadlines ($\beta = -.20$, $p < .05$), and more likely to persist in their engineering tasks ($\beta = .26$, $p < .01$).

As a group, the control variables and stereotype threat entered in Step 2 predicted a significant amount of the variance in choice, $F(1, 157) = 7.68$, $p < .01$ and persistence, $F(1, 157) = 6.36$, $p < .05$; but not delay, $F(1, 157) = 1.66$, $p = .20$, missing deadlines, F(1,

157) = 1.60, $p = .21$, effort, $F(1, 157) = 2.56$, $p = .11$, or continuation, $F(1, 157) = 3.22$, $p = .08$. Students who perceived lower levels of stereotype threat were more likely to choose to take more engineering courses ($\beta = -.23$, $p < .01$) and persist in their engineering tasks ($\beta = -.19$, $p < .05$). Gender and minority remained insignificant predictors of any of the achievement behaviors. Academic level remained a significant predictor of delay ($\beta = -.27$, $p < .01$), effort ($\beta = .23$, $p < .01$), and persistence ($\beta = .22$, $p < .01$). Self-reported GPA remained a significant predictor of delay ($\beta = -.23$, $p < .01$), missing deadlines ($\beta = -.20$, $p < .05$), and persistence ($\beta = .27$, $p < .01$).

Results from Step 3 indicate that adding the three expectancy for academic success in engineering components increased the amount of variance explained by 7% for delay, $F(3, 154) = 4.20$, $p < .01$; 8% for missing deadlines, $F(3, 154) = 4.73$, $p < .01$; 28% for choice, $F(3, 154) = 21.58$, $p < .001$; 23% for effort, $F(3, 154) = 16.22$, $p < .001$; 15% for persistence, $F(3, 154) = 9.97$, $p < .001$; and 45% for continuation, $F(3, 154) = 45.66$, $p < .001$. Students who expected successful engineering academic relationships with professors and classmates were less likely to miss deadlines ($\beta = -.18$, $p < .05$) and more likely to put forth effort to complete their engineering tasks ($\beta = .22$, $p < .01$). Students who expected that they would complete their engineering academic tasks were more likely to choose to take more engineering courses in the future ($\beta = .27$, $p < .01$), put forth effort to complete their engineering tasks ($\beta = .20$, $p < .05$), persist in their engineering tasks ($\beta = .28$, $p < .01$), and continue in the field of engineering ($\beta = .28$, $p < .01$). Students who expected that they would complete their engineering education were more likely to choose to take more engineering courses in the future ($\beta = .26$, $p < .01$), put forth effort to complete their engineering tasks ($\beta = .18$, $p < .05$), and continue in the field of engineering ($\beta = .43$, $p < .001$). Gender remained an insignificant predictor of any of the achievement behaviors. Academic level remained a significant predictor of delay ($\beta = -.21$, $p < .05$), whereas self-reported GPA remained a significant predictor of delay ($\beta = -.17$, $p < .05$) and persistence ($\beta = .18$, $p < .05$). In addition, minority became a significant predictor of continuation ($\beta = -.13$, $p < .05$), indicating that students who were underrepresented minorities were less likely to continue in the field of engineering. Academic level also became a significant predictor of choice ($\beta = -.16$, $p < .05$), indicating that students with higher academic levels were less likely to choose to take more engineering courses.

Adding the four task value components to the equation in Step 4 increased the amount of variance explained by approximately 8% for delay, $F(4, 150) = 3.71$, $p < .01$; 5% for missing deadlines, $F(4, 150) = 2.31$, $p = .06$; 20% for choice, $F(4, 150) = 16.73$, $p < .001$; 12% for effort, $F(4, 150) = 7.69$, $p < .001$; 8% for persistence, $F(4, 150) = 4.31$, $p < .01$; and 7% for procrastination, $F(4, 150) = 5.89$, $p < .001$. Students with higher levels of attainment value were more likely to choose to take more engineering courses in the future ($\beta = .24$, $p < .05$). Students with higher levels of intrinsic value were less likely to delay ($\beta = -.25$, $p < .05$) and more likely to choose to take more engineering courses ($\beta = .33$, $p < .001$) and put forth effort to complete their engineering tasks ($\beta = .34$, $p < .001$). Students with higher levels of cost were more likely to miss deadlines ($\beta = .17$, $p < .05$) and put forth more effort to complete their engineering tasks ($\beta = .21$, $p < .01$). When the other predictors were accounted for, utility value did not individually predict any of the achievement behaviors. Gender remained an insignificant predictor of any of the achievement behaviors, whereas minority remained a significant predictor of continuation (β = -.15, p < .05). Academic level remained a significant predictor of delay (β = -.22, p < .01) and choice (β = -.13, p < .05), whereas self-reported GPA remained a significant predictor of delay (β = -.21, p < .05) and persistence (β = .21, p < .01). Expectancy for successful engineering academic relationships remained a significant predictor of effort (β = .18, p < .05), whereas expectancy for completion of engineering education remained a significant predictor of choice (β = .19, p < .05), effort (β = .17, p < .05), and continuation (β = .39, p < .001).

Chapter V

Discussion

The current study examined college engineering students' choices, effort, persistence and continuation from expectancy-value theory's perspective. The study advances our understanding of 1) how motivational variables relate to college engineering students' achievement behaviors, and 2) the role of stereotype threat in predicting achievement behaviors. In general, the findings support our assumption that college engineering students' expectancy for success and subjective task values have significant relations with their choices, effort, persistence, and continuation.

Due to the limitations of the Revised Generalized Expectancy for Success Scale (Hale, Fiedler, & Cochran, 1992), we created the Expectancy for Academic Success Scale in Engineering. More specifically, the study was designed to advance the theoretical understanding of which motivational variables may be related to college engineering students' choices (to delay, to miss deadlines, and to take more engineering courses in the future), effort, persistence, and continuation. As a whole, the findings supported the expectations that college students' choices, effort, persistence, and continuation were significantly related to their expectancy for academic success in engineering, subjective task value, and engineering self-efficacy. Results also provided evidence for which aspects of stereotype threat, expectancy for academic success in engineering, and subjective task value could be specifically used to understand college engineering students' choices, effort, persistence, and continuation.

The Expectancy for Academic Success in Engineering Scale

The current study created the Expectancy for Academic Success in Engineering

Scale, which contains 13 items measuring students' expectancy for academic success in engineering. Principle component analysis (PCA) revealed three factors in this scale: *Expectancy for Successful Engineering Academic Relationships, Expectancy for Completion of Engineering Academic Tasks,* and *Expectancy for Completion of Engineering Education*. The Cronbach's alphas were equal to or greater than .75 for all three factors, indicating satisfactory reliabilities. All three factors revealed in the PCA were consistent with our hypothesis. Further research adapting and utilizing the Expectancy for Academic Success in Engineering Scale will provide valuable information on the appropriateness of each item and the reliability of each factor in other academic settings (e.g. science, mathematics).

The Pure Procrastination Scale

The current study adopted the Pure Procrastination Scale, which contains 12 items measuring students' tendency to put off responsibilities and miss deadlines, as well as delay the decision-making needed to complete important tasks. Principle component analysis (PCA) revealed two factors in this scale: *Delay* and *Missing Deadlines*. The Cronbach's alphas were equal to or greater than .74 for both factors, indicating satisfactory reliabilities. Both of the two factors revealed in the PCA were consistent with our hypothesis. Further research adapting and utilizing the Pure Procrastination Scale will provide valuable information on the appropriateness of each item and the reliability of each factor in other academic settings (e.g. liberal arts, social sciences, science).

Bivariate Relations Among Stereotype Threat, Self-Efficacy, Expectancies, and Subjective Task Values

In this study, we found that students with lower gender stereotype threat were more likely to expect that they would complete their engineering education. That is to say, students who were less vulnerable to the threat posed by confirming gender stereotypes were more likely to expect that they would complete their engineering education. This finding is consistent with previous research in which the participants showed consistently lower expectancies under stereotype threat (Stangor, Carr, & Kiang, 1998). Meanwhile, we found that students with lower racial stereotype threat were more likely to find their engineering tasks interesting and useful. In other words, students who were less vulnerable to the threat posed by confirming racial stereotypes were more likely to find their engineering tasks interesting and useful. The relationships between stereotype threat and subjective task values have not been studied explicitly before and this result provides us with some initial insight in this regard.

Besides, students with higher engineering self-efficacy were more likely to expect for successful engineering academic relationships, completion of engineering academic tasks, and completion of engineering education. These findings are in line with previous findings. For example, researchers found that self-efficacy was significantly correlated with outcome expectancy (Riggs & Knight, 1994; Boone, Abell, Volkmann, Arbaugh, & Lannin, 2011). Ocal and Aydin (2009) also found that collective efficacy beliefs significantly predicted future achievement expectations. Specifically, computer self-efficacy predicted effort expectancy and performance expectancy (Chiu & Wang, 2008). The results of the current study confirmed previous findings and expanded these findings to engineering contexts.

In addition, students with higher engineering self-efficacy were more likely to view their engineering tasks as important, interesting, and useful. Although the relations among self-efficacy and different components of subjective task values have not been examined separately before, researchers found that self-efficacy for learning and performance was significantly positively related to task value (Sungur, 2007; Lau, Liem, & Nie, 2008; Lawanto, Santoso, & Liu, 2012). The current research expanded previous studies by examining the four components of subjective task values and found that three of the four components (e.g. attainment value, intrinsic value, and utility value) were related to engineering self-efficacy.

The Choices to Delay and to Miss Deadlines

The current study examined academic procrastination as two academic choices: the choice to delay and the choice to miss deadlines. We found that engineering self-efficacy, expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, expectancy for completion of engineering education, attainment value, intrinsic value, and utility value were negatively associated with delay and missing deadlines. We also found that academic level, self-reported GPA, and intrinsic value negatively predicted delay. Moreover, self-reported GPA and expectancy for successful engineering academic relationships negatively predicted missing deadlines, whereas cost positively predicted missing deadlines.

Engineering self-efficacy was found to be negatively related to delay and missing deadlines, which is in line with meta-analytic reviews (e.g., Van Eerde, 2003; Ferrari, 2004; Steel, 2007) and empirical studies (e.g., Tuckman, 1991; Haycock, McCarthy, &

Skay, 1998; Wolters, 2003; Katz, Eilot, & Nevo, 2014) demonstrating procrastination is negatively related to students' self-efficacy. The relation between expectancy for academic success and academic procrastination has not been examined before. The present findings contribute to the view that the components of expectancy for academic success in engineering (e.g., expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, expectancy for completion of engineering education) are valuable related factors of students' choices to delay and to miss deadlines. The expectancy for successful engineering academic relationships may encourage students to establish and maintain successful relationships with professors and classmates, which provides them support systems to help them complete their engineering academic tasks and education successfully. The expectancies for completion of engineering academic tasks and education may encourage students to succeed in the field of engineering because they expect that they will complete engineering academic tasks and education, therefore, they are likely to try their best to find solutions or seek help from others instead of missing deadlines when they encounter difficulties.

The relations between different components of subjective task values and procrastination have not been examined separately; however, the relation between subjective task value and procrastination has been studied. Research found that procrastinators reported low task value (Cao, 2012). Cao (2012) studied subjective task value as one variable, whereas the current research separated subjective task values into four components: attainment value, intrinsic value, utility value, and cost. The present findings indicate that when tasks are interesting, students are intrinsically motivated to invest time and effort in completing these tasks, thus, they are less likely to delay. When a task is perceived as having lower cost, it means that the limitations of doing other activities when focusing on this task, efforts needed to complete this task, and emotional cost of the task are lower. Tasks with lower cost are usually easier and take less time to accomplish, which increases students' possibility of completing these tasks without missing deadlines.

Previous research found that there was no significant difference in delay and missing deadlines for students with different academic levels (Wolters et al., 2012). However, the current study indicates that academic level is a significant predictor of delay and missing deadlines. Students in higher academic levels show higher motivation, use more self-regulated learning strategies, and report more confidence in their ability to successfully complete coursework and tests (Wolters et al., 2012). Lack of these behaviors are likely to result in delay and miss deadlines. To earn a high GPA in college, it is important that students have good time management and self-regulation skills. Self-reported time management behaviors and attitudes are strong predictors of students' delay and missing deadlines (Wolters et al., 2012). Therefore, low self-reported GPA is likely to result in delay and miss deadlines.

The Choice to Take More Engineering Courses

Results showed that expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, and expectancy for completion of engineering education were positively related to the choice to take more engineering courses. Moreover, expectancy for completion of engineering academic tasks and expectancy for completion of engineering education were positive predictors of students' choice to take more engineering courses. The relation between students' expectancy for success and their choice to take more courses has not been examined before. The current study examined three components of expectancy for academic success in engineering and found that two of the three components predicted students' choice to take more engineering courses. It indicates that expectancy for success is a useful predictor of college engineering students' choice to take more engineering courses.

Results showed that attainment value, intrinsic value, utility value, and engineering self-efficacy were positively related to the choice to take more engineering courses. In addition, attainment value and intrinsic value were positive predictors of students' choice to take more engineering courses. The results supported Wolters's (2004) finding demonstrating self-efficacy was positively related to college students' choice to take more mathematics courses in the future. The results also supported previous findings (e.g., Eccles, 1984a; Eccles et al., 1984; Wigfield & Eccles, 1989) demonstrating students' task values in mathematics were strong predictors of their choice to take advanced high school math courses. The current study found that intrinsic value was a stronger predictor of students' choice to take more engineering courses than their expectancy for completion of engineering education, which is in line with Eccles (1984b) demonstrating students' task values in mathematics were stronger predictors of their choice to take math courses than their expectancy for success.

Results also showed that gender stereotype threat and racial stereotype threat were negatively related to the choice to take more engineering courses. Moreover, stereotype threat was a negative predictor of students' choice to take more engineering courses.

These findings were consistent with previous research findings. For example, Good (2001) found that elementary school girls did not choose to work on difficult math problems under stereotype threat conditions. Deemer et al. (2014) also found that stereotype threat had a significant negative indirect effect on female students' career choice intentions in physics. The current study supported and expanded previous findings in engineering contexts by examining the relation between college engineering students' stereotype threat and their choice to take more engineering courses. Academic level was also a negative predictor of students' choice to take more engineering courses, which has not been examined before. In other words, students in higher academic levels are less likely to choose to take additional engineering courses in the future, probably because they have already taken many engineering courses compared to students in lower academic levels.

Effort

Results showed that expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, and expectancy for completion of engineering education were positively related to students' self-reported effort in engineering tasks. These findings supported a previous finding demonstrating that expectancy for success and effort were positively related (Cox & Whaley, 2004). In addition, expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, and expectancy for completion of engineering education positively predicted students' effort. These findings were in line with a prior finding indicating that college expectations had a positive effect on American high school students' effort (Domina, Conley, & Farkas, 2011) and expanded the findings to college engineering students. The current study extended previous findings by examining three components of expectancy for academic success in engineering and found that all of them were positively related to effort and positively predicted effort. Students who expect that they will maintain successful relationships with their professors and classmates, complete their engineering academic tasks, and complete their engineering education are likely to be highly motivated to be successful, which will probably result in high level of effort invested in engineering tasks.

Results also showed that attainment value, intrinsic value, utility value, and engineering self-efficacy were positively related to students' self-reported effort in engineering tasks. In addition, intrinsic value, cost, and academic level positively predicted students' effort. These findings are consistent with previous findings. For example, researchers found people' perceptions of their self-efficacy predicted their effort on the task (Zeldin et al, 2008). Task value was also positively related to student effort in online courses (Yang, Cho, Mathew, & Worth, 2011). The current study examined four components of subjective task values and found that three of the four components were positively related to effort and two of them positively predicted effort. When the students perceive that the tasks are interesting, they are intrinsically motivated and are likely to put forth effort in completing them. Students also put forth more effort in completing tasks with higher cost. When a task is perceived as having higher cost, it means that the limitations of doing other activities when focusing on this task, efforts needed to complete this task, and emotional cost of this task are higher. Tasks with higher cost are usually more difficult and require more time to accomplish, which increases students' likelihood of putting forth more effort. Students' academic level positively predicted their effort, which indicated that students in higher academic levels put forth more effort in completing their tasks. Compared to students in lower academic levels, students in higher academic level are likely to have an accurate estimation of how difficult the tasks are and how much effort are needed to complete the tasks on time after spending more time in college. Therefore, students in higher academic levels are more likely to put forth effort in completing their engineering tasks.

Persistence

In this study, we found that expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, expectancy for completion of engineering education, attainment value, intrinsic value, utility value, and engineering self-efficacy were positively related to students' self-reported persistence in engineering tasks. The results supported previous findings. For example, researchers found people' perceptions of their self-efficacy predicted their persistence on the task (Zeldin et al, 2008). Higher self-efficacy was associated with greater persistence in general (Restubog et al., 2010). Engineering self-efficacy was positively correlated with female students' persistence in engineering (Marra et al. 2009). Matusovich et al. (2010) found that low attainment, intrinsic, and utility values and high cost value negatively influenced students' persistence. The current study expanded previous findings by examining three components of expectancy for success and found all of them were positively related to persistence and expectancy for completion of engineering academic tasks was a positive predictor of persistence. In other words, students who expect that they will complete their engineering academic tasks are likely to be highly motivated to be successful, which will probably result in high level of persistence in engineering tasks.

The effect of stereotype threat on persistence has not been examined in the context of engineering. The current study found that racial stereotype threat was negatively related to persistence and stereotype threat was a negative predictor of persistence, which contributes to the literature by indicating that students who were less vulnerable to the threat posed by confirming racial and gender stereotypes were more likely to persist in engineering tasks. In addition, academic level and self-reported GPA were positive predictors of persistence. That is to say, students with higher academic levels are more likely to persist than students with lower academic levels and students with higher self-reported GPA are more likely to persist than students with lower self-reported GPA.

Continuation

Results showed that engineering self-efficacy was positively related to students' continuation in the field of engineering, whereas racial stereotype threat was negatively related to continuation. Previous studies did not explore the relation between engineering self-efficacy and continuation and the current finding showed a positive relation between these two variables. That is to say, the more students believe in their ability in solving engineering problems, the more likely they will continue in the field of engineering. Previous research did not examine the association between stereotype threat and continuation and the current study showed a negative association between these two variables. In other words, students who were less vulnerable to the threat posed by confirming racial stereotypes were more likely to continue in the field of engineering. Minority was found to be a negative predictor of continuation, which indicated that underrepresented minorities were less likely to continue in the field of engineering. It provides a reason why the percentages are low for URMs in engineering programs and careers.

Results also showed that expectancy for successful engineering academic relationships, expectancy for completion of engineering academic tasks, expectancy for completion of engineering education, attainment value, intrinsic value, and utility value were positively related to students' self-reported continuation in the field of engineering. In addition, expectancy for completion of engineering academic tasks and expectancy for completion of engineering education were positive predictors of continuation. A previous research found that expectancy for success and intrinsic value were positively related to continuation in science careers (Nagengast et al., 2011), which was in line with the current findings. Jones et al. (2010) indicated that value-related constructs (attainment value, intrinsic value, and utility value) were better predictors of career plans than expectancy for success, however, the current findings indicated that expectancy for completion of engineering education was a better predictor of continuation than the four components of subjective task values. Contradictory results may be due to the use of different measures of expectancy for success and task values.

Implications & Limitations

Based on the findings of this study, there are several implications. First of all, universities and faculty should note the effect of stereotype threat on students' choices and persistence in engineering. Faculty and staff may not realize that they may have certain stereotypes toward female students or URMs. For example, they may think or say "there are fewer women engineers" or "most engineers are White or Asian men" without realizing that these judgments may trigger students' stereotype threat. Universities and colleges should provide relevant training to all faculty and staff to help them realize the possibilities of having stereotype threat and the negative consequences.

Because in-group role models are accomplished in the stereotyped field and share characteristics such as race or gender with the students (Marx & Roman, 2002), they have been empirically supported as a stereotype threat intervention (e.g., Stout, Dasgupta, Hunsinger, & McManus, 2011). Therefore, engineering departments should try to recruit more faculty who are females and URMs. The success about these faculty helps reduce female and URM students' concerns about positively representing their group in engineering (Shapiro, Williams, & Hambarchyan, 2013).

In addition, faculty should pay attention to testing conditions which may trigger stereotype threat and thus, have an impact on students' academic achievement. Smeding, Dumas, Loose, and Régner (2013) found that girls performed worse than boys on the math test when they took the math test before taking the verbal test; however, girls performed as well as boys when they took the math test after taking the verbal test. They also found that girls performed better on the math test in the verbal-math order condition than in the math-verbal order condition. These findings indicate that students' performance could improve if the order of their test testing changes.

Self-affirmation exercises involving engagement in a valuable activity or reflections on important parts of one's life that are different from the threatening field (e.g., Cohen, Garcia, Apfel, & Master, 2006) could also be provided to students and has received empirical support as a stereotype threat intervention (e.g., Martens, Johns, Greenberg, & Schimel, 2006). Wang et al. (2013) found that girls were more likely than boys to have good verbal skills; therefore, faculty could incorporate storytelling into engineering courses to increase female students' interest by making the materials practical (Wang, Degol, & Ye, 2015). Faculty may also focus on women and URMs' historical contributions to the engineering field and increase students' exposure and access to these engineers as role models (Steinke et al., 2007).

Interventions such as reflecting on quotations about the usefulness of mathematic and writing texts about the personal relevance of mathematics were more effective for girls than boys in increasing attainment value, intrinsic value, and utility value for mathematics (Gaspard et al., 2015), suggesting the importance and feasibility of retaining females in engineering. Faculty and staff should try their best to make students less vulnerable to the threat posed by confirming racial and gender stereotypes. The perceived racial stereotypes harm students' perceptions of their engineering tasks. Tasks may be perceived as uninteresting and useless when students perceive high racial stereotype threat. The perceived racial and gender stereotype threat also decrease students' choice to take more engineering courses and persistence in engineering tasks.

Secondly, faculty should be aware of the values of the tasks that they assign to students. Faculty should make engineering tasks important, interesting, and useful to make sure that they contribute to the mastery of the learning outcomes of the course. Research found that useful and relevant tasks were most related to overall course value (Jones, 2012), however, faculty may not have an accurate prediction of how important, interesting, and useful the tasks are. Universities usually require students to fill out course evaluations, which may be a useful source for faculty and administrators in higher education to identify interventions that can be applied to improve teaching and student satisfaction (Jones, 2012). It is important for faculty to consider using the information collected to improve teaching, but the reality is faculty may not always use the collected data for the improvement of teaching (Jones, 2012). Therefore, faculty can make better use of university course evaluations or design their own course evaluations which include more subjective questions asking students to evaluate how important, interesting, and useful the tasks are throughout the semester. Students should also be encouraged to give suggestions or examples of important, interesting, and useful tasks.

Wang et al. (2015) found that math task values started to have an effect on students' STEM achievement and career choices in high school. Though programs such as Great Explorations in Math and Science and Detroit Area Pre-College Engineering Program that emphasize student interest and engagement in STEM fields are increasing, task value as a motivator should become a greater focus of all undergraduate interventions or even k-12 interventions (Wang et al., 2015). Interventions such as reflecting on quotations about the usefulness of mathematic affected utility value more and also influenced attainment value and intrinsic value, whereas writing texts about the personal relevance of mathematics only impacted utility value (Gaspard et al., 2015). When the tasks are interesting and useful, students are less likely to become vulnerable to the threat posed by confirming racial stereotypes. When the tasks are important, interesting, and useful, students' engineering self-efficacy is likely to be promoted and they are not likely to delay or miss deadlines. When professors and instructors make engineering tasks important and interesting and encourage students to expect that they will complete their engineering education, students are likely to choose to take more engineering courses in the future. When the tasks are interesting, students are likely to put forth effort to complete their tasks.

Thirdly, faculty should carefully select the cost level of a task that will be assigned to students. They may try to complete the tasks themselves first and see how much time it takes them to complete the tasks so that they have a more accurate estimation of how long it would take the students to complete them. Faculty should have a better understanding of individual student's ability and achievement levels so that they can select the cost level of tasks without sacrificing the rigor and quality of education. After the tasks are due, faculty could collect feedbacks from students regarding the difficulty of the tasks and how much time they spent completing the tasks. When students perceive high cost, they are likely to miss deadlines but put forth effort to complete the task. That is to say, in the short term, students are more likely to miss the deadline when the task is of higher cost; in the long run, students are more likely to put forth effort to complete a task with higher cost.

Lastly, engineering faculty should try to promote the three components of students' expectancy for academic success in engineering in order to encourage them to put forth more effort to complete their engineering tasks. Researchers found a moderate positive relationship between professor/student rapport and students' expectancy for success (Estepp & Roberts, 2013), which indicates the importance of establishing good academic relationships with students. For example, faculty could encourage students to participate and collaborate in their research projects and organize academic-related activities for students. Engineering departments may establish a mentor program for freshmen, which will match an engineering student with a professor in the same department. Monthly meetings and activities could be organized by the departments or professors. When students' expectancy for completion of engineering academic tasks is increased, they are likely to persist in their engineering tasks. When students' expectancy for completion of engineering academic tasks and expectancy for completion of engineering education are increased, students are more likely to continue in the field of engineering.

There are several limitations in this study. First of all, the study is cross-sectional and does not generate causal inferences. Longitudinal studies and experiments that manipulate variables as potential antecedents of delay, missing deadlines, choice, effort, persistence, and continuation such as stereotype threat, self-esteem, and locus of control within the framework of the EVT are needed. A second limitation is that future studies on the underlying mechanism among student motivation and achievement behaviors may be extended in various ways. For example, future studies examining additional important student achievement behaviors such as a well-measured student achievement (e.g., GPA on transcripts) will provide valuable information to the literature. Moreover, future research addressing how students' school engagement may affect their tendency of procrastination in school activities can be interesting too. In addition, we found high correlation coefficients among several variables, indicating that these variables are very similar and multicollinearity may exist. Last but not least, this study only used quantitative measures; qualitative measures such as interviews and case studies as well as mixed methods research may be conducted in the future to investigate individual causes, differences, and patterns of students' choices, effort, persistence, and continuation. Notwithstanding, the findings support the expectancy-value model of achievement choice as a unique and useful perspective for understanding students' motivation and achievement-related behaviors.

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Appendix A

Tables

Table 1

Expectancy for Academic Success in Engineering Items and Factor Loadings for the Principle Component Analysis (N = 163)

Content	1	2	3
Expectancy for successful academic relationships in engineering (α = .75)			
In the future, I expect I will have successful academic relationships with my engineering professors.			.814
In the future, I expect I will have a positive influence on most of my classmates with whom I interact in engineering classes.			.761
In the future, I expect I will be able to work with my engineering classmates.			.748
Expectancy for completion of academic engineering tasks (α = .94)			
In the future, I expect I will succeed at most engineering academic tasks I try.	.723		
In the future, I expect I will carry through my engineering academic responsibilities successfully.	.792		
In the future, I expect I will handle unexpected engineering academic problems successfully.	.810		
In the future, I expect I will attain the engineering academic goals I set for myself.	.770		
In the future, I expect I will be able to solve my own engineering academic problems.	.853		
In the future, I expect I will succeed in the engineering projects I undertake.	.700		
In the future, I expect I will make my engineering academic plans work out well.	.759		
Expectancy for completion of engineering education (α = .89)			
In the future, I expect I will graduate with an engineering degree.		.878	
In the future, I expect I will graduate with passing grades in engineering courses.		.744	
In the future, I expect I will successfully complete my college engineering education.		.881	

Table 2

Academic Procrastination Items and Factor Loadings for the Principle Component Analysis (N = 163)

Content	1	2
Delay (α = .91)		
I delay making decisions in engineering tasks until it's too late.	.465	
Even after I make a decision in engineering tasks, I delay acting upon it.	.664	
I waste a lot of time on trivial matters before getting to any final decisions about my engineering tasks.	.689	
In preparation for some engineering academic deadlines, I often waste time by doing other things.	.790	
Even engineering tasks that require little else except sitting down and doing them, I find that they seldom get done for days.	.850	
I often find myself performing engineering tasks that I had intended to do days before.	.672	
For my engineering tasks, I am continually saying "I will do it tomorrow."	.791	
I generally delay before starting on engineering work I have to do.	.790	
Missing Deadlines (*α* = .74)		
When it comes to engineering tasks, I find myself running out of time.		.581
I do not get engineering tasks done on time.		.845
I am not very good at meeting deadlines in engineering tasks.		.823
Putting engineering tasks off till the last minute has cost me in the past.		.519

Table 3

Means, Standard Deviations, and Reliabilities for Variables (N = 163)

Variable	*M*	*SD*	*a*
Gender stereotype threat	1.61	.72	.87
Racal stereotype threat	1.68	.77	.90
Expectancy for academic success in engineering			
Expectancy for successful engineering academic relationships	4.05	.57	.75
Expectancy for completion of engineering academic tasks	4.13	.60	.94
Expectancy for completion of engineering education	4.36	.72	.89
Task values			
Attainment value	4.23	.65	.83
Intrinsic value	3.95	.62	.78
Utility value	4.39	.53	.73
Cost	4.40	.65	.89
Engineering self-efficacy	3.95	.66	.88
Choices			
Delay	2.95	.88	.91
Missing deadlines	2.55	.81	.74
Taking more engineering courses	3.91	.80	.78
Effort	3.95	.74	.79
Persistence	3.43	.76	.74
Continuation	3.88	.77	.66

Table 4

Pearson Correlations Among the Variables (N = 163)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Gender stereotype threat	—	.69**	-.12	-.11	-.16*	-.11	-.15	-.09	.06	-.14	.02	.08	-.18*	-.07	-.14	-.06
2. Racial stereotype threat		—	-.09	-.09	-.15	-.15	-.17*	-.16*	.02	-.19*	.07	.11	-.23**	-.07	-.16*	-.18*
3. Expectancy for successful engineering academic relationships			—	.54**	.40**	.51**	.44**	.46**	-.07	.40**	-.24**	-.27**	.38**	.41**	.32**	.42**
4. Expectancy for completion of engineering academic tasks				—	.65**	.51**	.54**	.43**	-.01	.70**	-.34**	-.28**	.47**	.46**	.45**	.59**
5. Expectation for completion of engineering education					—	.43**	.39**	.35**	-.03	.49**	-.25**	-.22**	.47**	.43**	.36**	.64**
6. Attainment value						—	.67**	.74**	.20*	.57**	-.35**	-.29**	.61**	.47**	.45**	.53**
7. Intrinsic value							—	.57**	.04	.60**	-.39**	-.23**	.63**	.52**	.45**	.52**
8. Utility value								—	.31**	.46**	-.33**	-.28**	.52**	.35**	.39**	.47**
9. Cost									—	-.01	-.07	.11	-.01	.19*	.01	-.05
10. Engineering self-efficacy										—	-.35**	-.30**	.41**	.37**	.41**	.47**
11. Delay											—	.65**	-.41**	-.49**	-.70**	-.30**
12. Missing deadlines												—	-.38**	-.39**	-.53**	-.21**
13. Choice													—	.45**	.47**	.67**
14. Effort														—	.50**	.38**
15. Persistence															—	.42**
16. Continuation																—

Note. $N = 163$.

* $p < .05$, ** $p < .01$.

Table 5

Summary of Hierarchical Regression Analyses Predicting Achievement Behaviors (N = 163)

Variable	Delay[a]			Missing Deadlines[b]			Choice[c]			Effort[d]			Persistence[e]			Continuation[f]		
	B	*SE* B	*β*	B	*SE* B	*β*	B	*SE* B	*β*	B	*SE* B	*β*	B	*SE* B	*β*	B	*SE* B	*β*
Step 1																		
Gender	.17	.16	.09	-.06	.15	-.03	.09	.15	.05	-.15	.14	-.09	-.05	.14	-.03	.06	.14	.04
Minority	-.23	.14	-.13	.02	.13	.01	.01	.13	.00	.15	.12	.10	.18	.12	.12	-.08	.13	-.05
Year	-.23	.07	-.26**	-.09	.07	-.11	-.03	.07	-.04	.16	.06	.21*	.15	.06	.19*	.08	.06	.11
GPA	-.21	.07	-.22**	-.17	.07	-.20*	-.02	.07	-.03	.04	.06	.06	.21	.07	.26**	.08	.07	.10
Step 2																		
Gender	.22	.16	.11	-.01	.15	-.00	-.03	.15	-.02	-.20	.14	-.12	-.14	.14	-.08	-.01	.15	-.01
Minority	-.22	.14	-.12	.03	.13	.02	-.01	.13	-.00	.15	.12	.10	.17	.12	.11	-.09	.13	-.06
Year	-.24	.07	-.27**	-.10	.07	-.12	-.01	.07	-.01	.17	.06	.23**	.17	.06	.22**	.10	.06	.13
GPA	-.21	.07	-.23**	-.17	.07	-.20*	-.02	.07	-.02	.05	.06	.06	.21	.06	.27**	.09	.07	.11
Stereotype threat	.12	.10	.09	.12	.10	.10	-.27	.10	-.23**	-.13	.09	-.12	-.21	.09	-.19*	-.17	.09	-.15
Step 3																		
Gender	.12	.16	.06	-.11	.15	-.06	.14	.13	.08	-.05	.13	-.03	-.02	.13	-.01	.18	.11	.10
Minority	-.14	.14	-.08	.11	.13	.07	-.12	.11	-.08	.04	.11	.03	.07	.11	.05	-.21	.09	-.13*
Year	-.18	.07	-.21*	-.06	.07	-.07	-.12	.06	-.16*	.09	.06	.12	.09	.06	.11	-.05	.05	-.07
GPA	-.16	.07	-.17*	-.12	.07	-.15	-.11	.06	-.13	-.03	.06	-.03	.14	.06	.18*	-.02	.05	-.02
Stereotype threat	.05	.10	.04	.06	.10	.05	-.13	.08	-.11	-.02	.08	-.02	-.12	.08	-.11	.00	.07	.00
Expectancy for successful engineering academic relationships	-.16	.14	-.10	-.26	.13	-.18*	.20	.11	.14	.29	.11	.22**	.15	.11	.11	.16	.10	.12
Expectancy for completion of engineering academic tasks	-.27	.16	-.18	-.18	.15	-.14	.36	.13	.27**	.25	.12	.20*	.36	.13	.28**	.36	.11	.28**
Expectancy for completion of engineering education	-.05	.12	-.04	-.03	.11	-.03	.29	.10	.26**	.19	.09	.18*	.09	.10	.08	.47	.08	.43***
Step 4																		
Gender	.18	.16	.09	-.09	.15	-.05	.06	.11	.04	-.09	.12	-.05	-.06	.13	-.04	.14	.11	.08
Minority	-.08	.14	-.05	.09	.13	.06	-.19	.10	-.12	-.06	.10	-.04	.04	.11	.03	-.24	.09	-.15*
Year	-.19	.07	-.22**	-.09	.07	-.11	-.10	.05	-.13*	.06	.05	.09	.10	.06	.14	-.03	.05	-.04
GPA	-.19	.07	-.21*	-.13	.07	-.15	-.07	.05	-.09	.00	.05	.00	.17	.06	.21**	.00	.05	.00
Stereotype threat	.02	.10	.02	.04	.09	.03	-.08	.07	-.07	.00	.07	.00	-.10	.08	-.09	.03	.07	.03
Expectancy for successful engineering academic	-.00	.15	-.00	-.12	.14	-.08	-.06	.10	-.04	.24	.11	.18*	-.01	.12	-.01	.01	.10	.01

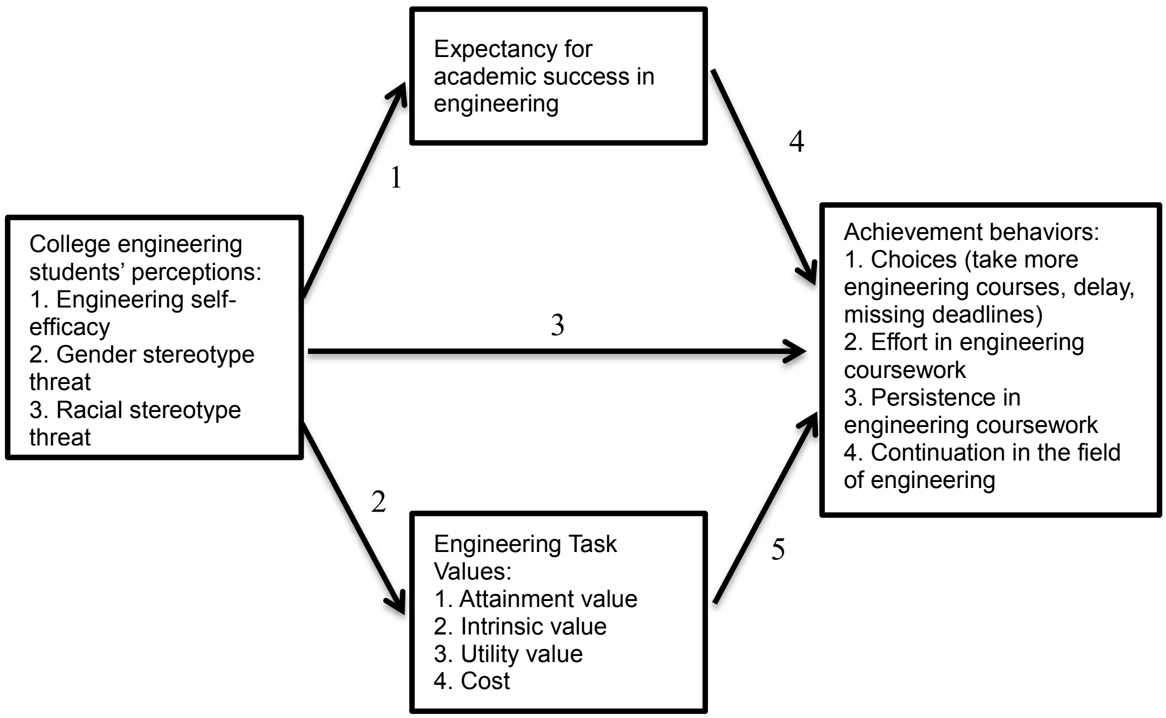
relationships																		
Expectancy for completion of engineering academic tasks	-.07	.16	-.05	-.12	.16	-.09	.08	.12	.06	.08	.12	.06	.19	.13	.15	.21	.11	.17
Expectancy for completion of engineering education	-.01	.12	-.01	.02	.11	.02	.21	.09	.19*	.18	.09	.17*	.04	.10	.04	.42	.08	.39***
Attainment value	-.07	.17	-.05	-.11	.16	-.09	.30	.12	.24*	.15	.12	.14	.15	.14	.13	.11	.11	.09
Intrinsic value	-.36	.15	-.25*	.03	.14	.03	.43	.11	.33***	.41	.11	.34***	.24	.12	.20	.19	.10	.15
Utility value	-.18	.19	-.11	-.34	.18	-.22	.17	.13	.11	-.24	.14	-.17	.16	.15	.11	.24	.13	.16
Cost	.02	.11	.02	.22	.11	.17*	-.08	.08	-.07	.24	.08	.21**	-.07	.09	-.06	-.09	.07	-.07

Note. $N = 163$.
[a] $R^2 = .09$, $p < .01$ for Step 1; $R^2\ \Delta = .01$, $p = .25$ for Step 2; $R^2\ \Delta = .07$, $p < .01$ for Step 3; $R^2\ \Delta = .08$, $p < .01$ for Step 4.
[b] $R^2 = .04$, $p = .13$ for Step 1; $R^2\ \Delta = .01$, $p = .21$ for Step 2; $R^2\ \Delta = .08$, $p < .01$ for Step 3; $R^2\ \Delta = .05$, $p = .06$ for Step 4.
[c] $R^2 = .00$, $p = .97$ for Step 1; $R^2\ \Delta = .16$, $p < .01$ for Step 2; $R^2\ \Delta = .28$, $p < .001$ for Step 3; $R^2\ \Delta = .20$, $p < .001$ for Step 4.
[d] $R^2 = .05$, $p = .10$ for Step 1; $R^2\ \Delta = .01$, $p = .14$ for Step 2; $R^2\ \Delta = .23$, $p < .001$ for Step 3; $R^2\ \Delta = .12$, $p < .001$ for Step 4.
[e] $R^2 = .08$, $p < .05$ for Step 1; $R^2\ \Delta = .03$, $p < .05$ for Step 2; $R^2\ \Delta = .15$, $p < .001$ for Step 3; $R^2\ \Delta = .08$, $p < .01$ for Step 4.
[f] $R^2 = .02$, $p = .45$ for Step 1; $R^2\ \Delta = .02$, $p = .07$ for Step 2; $R^2\ \Delta = .45$, $p < .001$ for Step 3.; $R^2\ \Delta = .07$, $p < .001$ for Step 4.
* $p < .05$, ** $p < .01$, *** $p < .001$

Appendix B

Figures

Figure 1. The conceptual framework of the current research.



Appendix C

Survey

Part One

Please answer the following demographic questions by choosing the option that best describes you or filling in the blanks.

1. **What is your gender?**
   Male
   Female

2. **What is your age?**
3. **Which of the following best describe your race (check all that apply)?**
   Native American/American Indian
   Asian/Pacific Islander
   Black/African American
   Hispanic/Latino
   Caucasian/White
   Multi-racial
   Other, specify_____________________

4. **What year is it for you at UH?**
   1st
   2nd
   3rd
   4th
   Other, specify____________

5. **Please indicate how many semesters you have taken engineering courses.**
6. **Please indicate how many engineering courses you have taken at UH (including the engineering courses you enrolled this semester).**
7. **What is your major (check all that apply)?**
   Biomedical Engineering
   Chemical & Biomolecular Engineering
   Petroleum Engineering
   Civil & Environmental Engineering
   Electrical & Computer Engineering
   Industrial Engineering
   Mechanical Engineering
   Honors College
   Other, specify_______________

8. As of the start of the Spring 2014, what is your UH major GPA (in engineering courses)?

3.5 or higher
3.0-3.49
2.5-2.99
2.0-2.49
1.99 or lower

9. Are you the first person in your immediate family to go to college?

No
Yes

10. Are you an international student?

No
Yes

11. Did you transfer to UH from another institution?

No
Yes

12. Have you received a Pell Grant to help you pay for college?

No
Yes

Part Two

This is part 2 of 7; overall it consists of 10 statements. Each statement describes a belief in engineering performance. Please think about all engineering courses that you have taken so far and rate the extent to which you agree or disagree with each of the following statements from "strongly disagree" to "strongly agree".

13. I believe that my ability to perform well on engineering tests is affected by my gender.

Strongly disagree Disagree Neutral
Agree Strongly agree

14. I believe that if I perform poorly on an engineering test, the professor will attribute my poor performance to my gender.

Strongly disagree Disagree Neutral
Agree Strongly agree

15. I believe that if I perform well on an engineering test, the professor will attribute my good performance to my gender.

Strongly disagree Disagree Neutral
Agree Strongly agree

16. I believe that negative stereotypes about my gender increase my anxiety about engineering tests.

Strongly disagree Disagree Neutral
Agree Strongly agree

17. I believe that positive stereotypes about my gender increase my anxiety about engineering tests.

Strongly disagree Disagree Neutral
Agree Strongly agree

18. I believe that my ability to perform well on engineering tests is affected by my race.

Strongly disagree Disagree Neutral
Agree Strongly agree

19. I believe that if I perform poorly on an engineering test, the professor will attribute my poor performance to my race.

Strongly disagree Disagree Neutral
Agree Strongly agree

20. I believe that if I perform well on an engineering test, the professor will attribute my good performance to my race.

Strongly disagree Disagree Neutral
Agree Strongly agree

21. I believe that negative stereotypes about my race increase my anxiety about engineering tests.

Strongly disagree Disagree Neutral
Agree Strongly agree

22. I believe that positive stereotypes about my race increase my anxiety about engineering tests.

Strongly disagree Disagree Neutral
Agree Strongly agree

Part Three

This is part 3 of 7; overall it consists of 13 statements. Each statement describes an expectancy for academic success in engineering. Please think about all engineering courses that you have taken so far and rate the extent to which you agree or disagree with each of the following statements from "strongly disagree" to "strongly agree".

23. In the future, I expect I will have successful academic relationships with my engineering professors.

Strongly disagree Disagree Neutral
Agree Strongly agree

24. In the future, I expect I will have a positive influence on most of my classmates with whom I interact in engineering classes.

Strongly disagree Disagree Neutral
Agree Strongly agree

25. In the future, I expect I will be able to work with my engineering classmates.

Strongly disagree Disagree Neutral
Agree Strongly agree

26. In the future, I expect I will succeed at most engineering academic tasks I try.

Strongly disagree Disagree Neutral
Agree Strongly agree

27. In the future, I expect I will carry through my engineering academic responsibilities successfully.

Strongly disagree Disagree Neutral
Agree Strongly agree

28. In the future, I expect I will handle unexpected engineering academic problems successfully.

Strongly disagree Disagree Neutral
Agree Strongly agree

29. In the future, I expect I will attain the engineering academic goals I set for myself.

Strongly disagree Disagree Neutral
Agree Strongly agree

30. In the future, I expect I will be able to solve my own engineering academic problems.

Strongly disagree Disagree Neutral
Agree Strongly agree

31. In the future, I expect I will succeed in the engineering projects I undertake.

Strongly disagree Disagree Neutral
Agree Strongly agree

32. In the future, I expect I will make my engineering academic plans work out well.

Strongly disagree Disagree Neutral
Agree Strongly agree

33. In the future, I expect I will graduate with an engineering degree.

Strongly disagree Disagree Neutral
Agree Strongly agree

34. In the future, I expect I will graduate with passing grades in engineering courses.

Strongly disagree Disagree Neutral
Agree Strongly agree

35. In the future, I expect I will successfully complete my college engineering education.

Strongly disagree Disagree Neutral
Agree Strongly agree

Part Four

This is section 4 of 7; overall it consists of 15 statements. Each statement describes a perception of engineering classes. Please think about all engineering courses that you have taken so far and rate the extent to which you agree or disagree with each of the following statements from "strongly disagree" to "strongly agree".

36. I am really keen to learn a lot in my engineering classes.

Strongly disagree Disagree Neutral
Agree Strongly agree

37. Engineering classes are important to me personally.

Strongly disagree Disagree Neutral
Agree Strongly agree

38. It is important to me personally to be a good engineering student.

Strongly disagree Disagree Neutral
Agree Strongly agree

39. I enjoy puzzling over engineering problems.

Strongly disagree Disagree Neutral
Agree Strongly agree

40. I always look forward to my engineering classes.

Strongly disagree Disagree Neutral
Agree Strongly agree

41. When I am working on an engineering problem, I sometimes do not notice time passing.

Strongly disagree Disagree Neutral
Agree Strongly agree

42. I like attending stimulating engineering lectures.

Strongly disagree Disagree Neutral
Agree Strongly agree

43. I enjoy advancing my knowledge by exploring new and challenging ideas in my engineering classes.

Strongly disagree Disagree Neutral
Agree Strongly agree

44. I will need good academic skills in engineering for my later life (training, studies, work).

Strongly disagree Disagree Neutral
Agree Strongly agree

45. Good grades in my engineering courses can be of great value to me later.

Strongly disagree Disagree Neutral
Agree Strongly agree

46. What I have learned in my engineering classes will be very useful for what I want to do in the future.

Strongly disagree Disagree Neutral
Agree Strongly agree

47. A bachelor's degree in engineering can help me support myself in the future.

Strongly disagree Disagree Neutral
Agree Strongly agree

48. I would have to sacrifice a lot of free time to be good at my engineering schoolwork.

Strongly disagree Disagree Neutral
Agree Strongly agree

49. I would have to invest a lot of time to get good grades in my engineering courses.

Strongly disagree Disagree Neutral
Agree Strongly agree

50. I would have to work very hard to pursue my engineering academic goal.

Strongly disagree Disagree Neutral
Agree Strongly agree

Part Five

This is section 5 of 7; overall it consists of 5 statements. Each statement describes a belief to complete engineering courses. Please think about all engineering courses that you have taken so far and rate the extent to which you agree or disagree with each of the following statements from "strongly disagree" to "strongly agree".

51. I am confident I can do an excellent job on the assignments and tests in my engineering courses.

Strongly disagree Disagree Neutral
Agree Strongly agree

52. I am certain I can master the skills being taught in my engineering classes.

Strongly disagree Disagree Neutral
Agree Strongly agree

53. I am confident I can understand the most complex material presented by my engineering instructors.

Strongly disagree Disagree Neutral
Agree Strongly agree

54. I am certain I can understand the most difficult material presented in the readings for engineering courses.

Strongly disagree Disagree Neutral
Agree Strongly agree

55. I am very confident I can learn the basic concepts taught in my engineering courses.

Strongly disagree Disagree Neutral
Agree Strongly agree

Part Six

This is section 6 of 7; overall it consists of 12 statements. Each statement describes a work habit in engineering. Please think about all engineering courses that you have taken so far and rate the extent to which you agree or disagree with each of the following statements from "strongly disagree" to "strongly agree".

56. I delay making decisions in engineering tasks until it's too late.

Strongly disagree Disagree Neutral
Agree Strongly agree

57. Even after I make a decision in engineering tasks, I delay acting upon it.

Strongly disagree Disagree Neutral
Agree Strongly agree

58. I waste a lot of time on trivial matters before getting to any final decisions about my engineering tasks.

Strongly disagree Disagree Neutral
Agree Strongly agree

59. In preparation for some engineering academic deadlines, I often waste time by doing other things.

Strongly disagree Disagree Neutral
Agree Strongly agree

60. Even engineering tasks that require little else except sitting down and doing them, I find that they seldom get done for days.

Strongly disagree Disagree Neutral
Agree Strongly agree

61. I often find myself performing engineering tasks that I had intended to do days before.

Strongly disagree Disagree Neutral
Agree Strongly agree

62. For my engineering tasks, I am continually saying "I will do it tomorrow."

Strongly disagree Disagree Neutral
Agree Strongly agree

63. I generally delay before starting on engineering work I have to do.

Strongly disagree Disagree Neutral
Agree Strongly agree

64. When it comes to engineering tasks, I find myself running out of time.

Strongly disagree Disagree Neutral
Agree Strongly agree

65. I do not get engineering tasks done on time.

Strongly disagree Disagree Neutral
Agree Strongly agree

66. I am not very good at meeting deadlines in engineering tasks.

Strongly disagree Disagree Neutral
Agree Strongly agree

67. Putting engineering tasks off till the last minute has cost me in the past.

Strongly disagree Disagree Neutral
Agree Strongly agree

Part Seven

This is section 7 of 7; overall it consists of 16 statements. Each statement describes a current or a future choice. Please think about all engineering courses that you have taken so far and rate the extent to which you agree or disagree with each of the following statements from "strongly disagree" to "strongly agree".

68. I look forward to taking more engineering courses in the future.

Strongly disagree Disagree Neutral
Agree Strongly agree

69. I will not take another engineering course unless it is required.

Strongly disagree Disagree Neutral
Agree Strongly agree

70. I plan to avoid taking any course that involves engineering.

Strongly disagree Disagree Neutral
Agree Strongly agree

71. If I had a choice, I would take an engineering course rather than something else.

Strongly disagree Disagree Neutral
Agree Strongly agree

72. I always work as hard as I can to finish my engineering assignments.

Strongly disagree Disagree Neutral
Agree Strongly agree

73. I do not put a lot of effort into finishing my engineering work.

Strongly disagree Disagree Neutral
Agree Strongly agree

74. I put more effort into engineering classes than I do in my other classes.

Strongly disagree Disagree Neutral
Agree Strongly agree

75. I always put a lot of effort into doing my engineering work.

Strongly disagree Disagree Neutral
Agree Strongly agree

76. I get distracted very easily when I am studying for engineering.

Strongly disagree Disagree Neutral
Agree Strongly agree

77. I get started on doing my engineering work but often do not stick with it for very long.

Strongly disagree Disagree Neutral
Agree Strongly agree

78. Even if my engineering work is dull or boring, I keep at it until I am finished.

Strongly disagree Disagree Neutral
Agree Strongly agree

79. I often begin engineering assignments but give up before I am done.

Strongly disagree Disagree Neutral
Agree Strongly agree

80. I will pursue graduate study in engineering.

Strongly disagree Disagree Neutral
Agree Strongly agree

81. My eventual career after graduation will directly pertain to engineering.

Strongly disagree Disagree Neutral
Agree Strongly agree

82. I often think about changing to non-engineering major.

Strongly disagree Disagree Neutral
Agree Strongly agree

83. It is likely that I will change to non-engineering major.

Strongly disagree Disagree Neutral
Agree Strongly agree

Appendix D

Consent to Participate in Research

UNIVERSITY OF HOUSTON

CONSENT TO PARTICIPATE IN RESEARCH

Exploring College Engineering Students' Stereotype Threat and Academic Procrastination from Expectancy-Value Theory's Perspective

You are being invited to participate in a research project conducted by Fan Wu from the Department of Educational Psychology at the University of Houston. This study is part of dissertation that is conducted under the supervision of Weihua Fan, Ph.D. from the Department of Educational Psychology at the University of Houston.

NON-PARTICIPATION STATEMENT

Your participation is voluntary and you may refuse to participate or withdraw at any time without penalty or loss of benefits to which you are otherwise entitled. You may also refuse to answer any question. As a student, a decision to participate or not or to withdraw your participation will have no effect on your standing.

PURPOSE OF THE STUDY

The purpose of this study is to investigate how stereotype threat in engineering, college engineering students' expectancy for academic success, perceived engineering task values (attainment value, intrinsic value, utility value, and cost), and engineering self-efficacy relate to their academic procrastination in engineering tasks (delay and missing deadlines), effort and persistence in engineering schoolwork, choice of taking more engineering courses, and continuation in the field of engineering. The duration of this study is about a year, but participants will only volunteer for a single session that will take about 20-30 minutes.

PROCEDURES

You will be one of approximately 200 subjects at the University of Houston asked to participate in this project.

Participation in this research involves one session where participants will be asked to provide some demographic data and complete a questionnaire concerning stereotype threat, academic procrastination, beliefs, and achievement behaviors. There are seven sections in the questionnaire and 83 items in total. The first section asks you to report some basic demographic characteristics (e.g., gender, age). The remaining six sections ask you to read a short statement and indicate a response on a scale from "strongly disagree” to “strongly agree”.

CONFIDENTIALITY

Your participation in this project will be kept confidential, and your responses will remain anonymous.

RISKS/DISCOMFORTS

There are no foreseeable risks in this study.

BENEFITS

While you will not directly benefit from participation, your participation may help researchers better understand the relationships among stereotype threat, expectancy for academic success in engineering, engineering task values, engineering self-efficacy, academic procrastination in engineering tasks, effort and persistence in engineering schoolwork, choice of taking more engineering courses, and continuation in the field of engineering. Such information can help educators and policy makers solve the problems in undergraduate engineering education (e.g. high attrition rates and consistent underrepresentation of women and underrepresented minorities).

ALTERNATIVES

Participation in this project is voluntary and the only alternative to this project is non-participation.

PUBLICATION STATEMENT

The results of this study may be published in professional and/or scientific journals. It may also be used for educational purposes or for professional presentations. However, no individual subject will be identified.

If you have any questions, you may contact Fan Wu at fwu7@uh.edu, or (713) 876-2599. You may also contact Dr. Weihua Fan at wfan@central.uh.edu, or (713) 743-9824.

ANY QUESTIONS REGARDING YOUR RIGHTS AS A RESEARCH SUBJECT MAY BE ADDRESSED TO THE UNIVERSITY OF HOUSTON COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS (713-743-9204).

Principal Investigator's Name: Fan Wu

Signature of Principal Investigator: ____________________

Appendix E

Recruitment Letter

Hello, everyone! My name is Fan Wu. I am a doctoral candidate from the Department of Educational Psychology at the University of Houston. I would like to invite you to participate in my dissertation research entitled "Exploring College Engineering Students' Stereotype Threat and Academic Procrastination from Expectancy-Value Theory's Perspective". The purpose of this study is to investigate how college engineering students' stereotype threat, expectancy for academic success, task values, engineering self-efficacy relate to their academic procrastination, effort and persistence in engineering schoolwork, the choice of taking more engineering courses, and continuation in the field of engineering. Now I am going to give you a copy of the cover letter and the survey. Please read the cover letter first, which gives you a description of the study. If you agree to participate, you can complete the survey and give it back to me. Please do not write any personal information on the survey. Thank you very much!