UNDERSTANDING WOMEN’S CHOICES TO ENROLL IN ENGINEERING:

A CASE STUDY

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by
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Abstract

The underrepresentation of women in science, technology, engineering and mathematics (STEM) college programs is a troublesome local, national and global phenomenon. The topic of this doctoral thesis specifically focused on the underrepresentation of women in the field of engineering and more specifically on the factors that women may perceive as chiefly motivating them to choose engineering as a college major. By not choosing to major in engineering, women forego intellectual opportunities and the financial rewards that engineering careers can provide. Their absence means that the field of engineering also suffers from the lack of contributions from a diverse workforce. Women who graduated from a specific community college’s engineering program in the United States were the focus of this qualitative study. Grounded in achievement motivation theory, and in particular expectancy-value theory of academic and career choice, this research was guided by two questions: How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering? How do women perceive their subjective task values as influencing their decisions to enroll in engineering? This single, holistic case study with one main unit of analysis incorporated a written questionnaire, individual interviews and a focus group meeting as the three instruments used to collect data. The qualitative data, cyclically coded, shed light on the complex mechanisms of academic and career choice.

Keywords: career choice, community colleges, engineering, gender, STEM
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Chapter One: Introduction

Purpose of the Study

The purpose of this study was to research the positive motivational dynamics that women perceive as having influenced them to choose engineering as their college major. Many recommendations that are being made on how to attract more women into engineering are based primarily on increasing women’s self-perceptions of their skills and abilities (Allison & Cossette, 2007; Eccles et al., 1993). Eccles (1993) posits that recruitment interventions should not be based solely on increasing women’s self-efficacies. She suggests that even women with strong academic self-efficacies and expectations for success in engineering, might not choose engineering if they do not associate strong personal values with earning an engineering degree. Knowing why women at a community college chose engineering may help secondary and higher education institutions in their endeavors to motivate more women to also choose engineering.

Statement of the Problem and Its Significance

Women historically have been, and continue to be, underrepresented in the engineering programs offered at a community college located in the northeastern United States (U.S.). This phenomenon is not unexpected when one considers national data that reveals how women historically have been underrepresented in undergraduate engineering programs in colleges across the entire country (National Science Foundation, National Center for Science and Engineering Statistics, 2011). Actually the under enrollment of women in engineering at this particular community college is not unlike the under enrollment of women in engineering programs at colleges throughout the western world. The underrepresentation of women in engineering, in reality, is a far reaching global problem (Gill, Sharp, Mills, & Franzway, 2008).
Regardless of whether this underrepresentation of women in engineering is occurring locally, nationally or even globally, one may ask why it is a problem. One reason is that women who forego engineering as an academic choice are missing opportunities to earn rewarding salaries that science, technology, engineering and mathematics (STEM) professions typically provide. A recent U.S. Department of Commerce report indicates that in 2009, women comprised 49% of the college-educated workforce, but only 24% of the college-educated STEM workforce (Beede et al., 2011). When considering the career engineering, which is just one of the components of the acronym STEM, the numbers were even worse according to that same report. Evidently in one of the years examined, 2009, women held only 14% of the engineering professional and technical support jobs in this country. The financial rewards for those women who did hold STEM related jobs in the U.S. in 2009 were noteworthy. They earned 33% percent more in salary than comparable women in non-STEM jobs.

Another reason why the underrepresentation of women in engineering is a problem is that women are missing opportunities to contribute their personal and professional expertise toward the many specific disciplines within the field of engineering. For instance, within the environmental engineering discipline, women engineers could contribute not only academic and professional expertise, but could also share in-depth personal experiences with household products such as disposable diapers and sports drink containers. Within the discipline of mechanical engineering, women could provide very valuable personal insights, as well as engineering ingenuity, with regard to the development and evaluation of consumer products such as infant car seats, hair dryers and the minivan. The relatively few women that are employed in STEM professions can and do provide gender based perspectives and contribute unique ideas to solve problems that women face. However, the overwhelmingly homogeneous nature of the
engineering workforce, which the National Science Foundation’s Division of Science Resource Statistics (2011) found to be comprised of 74% men, and more particularly 55% white men in this country, results in professional limitations towards developing people-centered solutions.

The absence of women in engineering is troublesome in many ways. For instance, it is a missed opportunity for the engineering profession (Milgram, 2011). In its entirety, engineering is a field that ultimately tries to benefit people, and as other researchers have pointed out, the engineering profession can only gain if its workforce is as diverse as the people that it serves (Chubin, May & Babco, 2005). “While the engineering profession continues to be comprised of a narrow range of people – far narrower than the population that it serves – its potential to develop innovative and people-centered solutions is going to be limited” (Gill et al., 2008, p. 391).

What is the educational significance of the problem? An important gateway to an engineering career is an engineering degree, and fewer women than men earn engineering degrees. A recent report issued by the National Center for Education Statistics indicates that only 17% of bachelor’s degrees in engineering and engineering technologies and 10% of associate’s degrees in engineering and engineering technologies were awarded to women during the period 2009-2010 (Aud et al., 2012). Therefore, if those percentages hold steady, increasing the number of women engineers primarily requires increasing the number of engineering students. Gill et al. (2008) indicates that governments worldwide are looking increasingly toward education to produce more qualified engineers, because economic advancement, global competitiveness, homeland security, and sustainability are all affected by the skills of the populace. According to a 2007 statement by the chairman of the National Science Board “…it is essential that all American citizens have the necessary scientific, technological, and
mathematical knowledge and skills to make informed personal choices and voting decisions and to thrive in the current technologically rich, global marketplace” (Beering, 2007, p. 2). Women can acquire such knowledge and skills through the completion of an engineering degree program.

Community colleges, in collaboration with targeted and proven recruitment and retention programs, may be able to offer a solution to the mystery of the paucity of women engineers. Many community colleges offer STEM degree programs that lead to associate’s degrees and transfer opportunities to four-year institutions (Costello, 2012). In 2010 there were 977 community colleges in this country, representing a viable sector of education (Aud et al., 2012). According to that report, during the fall 2010 semester, community colleges enrolled over 7.2 million students and 57% of them were female. However, during the 2010-2011 academic year, women were awarded only 10% of associate’s degrees in engineering and engineering technologies from both public and private two-year colleges combined.

Research Questions

Information acquired through research is an important piece in the women in engineering puzzle (Cech, 2006). Substantial research has focused on engineering students enrolled in four-year colleges and at secondary schools, yet limited research has been conducted on the factors that influence gender disparity in engineering programs at community colleges (Starobin & Laanan, 2005; Starobin & Laanan, 2008). Costello (2012) urges that research is needed to explore the factors that encourage women, particularly low-income women, to enter and succeed in STEM programs at community colleges. Beddoes and Borrego (2011) maintain that conversations with women are necessary to fill in statistical research gaps. According to Gill et al. (2008), “Little is known about the motivation to enter engineering courses, especially with respect to women…” (p. 392).
Two research questions guided this study, and they were:

1. How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering?
2. How do women perceive their subjective task values as influencing their decisions to enroll in engineering?

**Theoretical Framework**

The theoretical framework that guided this research was Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices. It is an achievement motivational theory that has been applied to a wide spectrum of life’s activities and choices, including gendered differences among educational and occupational choices. Eccles and her colleagues are leading researchers in the field of academic and occupational choice (Pintrich & Schunk, 1996; Hill, Corbett, & St. Rose, 2010; Bembenutty, 2008). Eccles has spent over 30 years developing and expanding her theoretical model of the social, cultural and psychological influences on achievement related choices, originally applying it within the educational (mathematics achievement) domain, and then extending it to the occupational outcomes domain (Bembenutty, 2008; Eccles (Parsons) et al., 1983; Wigfield & Eccles, 2000).

Achievement motivation theorists, notably Eccles, endeavor to explain why individuals make the choices they do. There are a variety of constructs that have been posited over the years in the motivation field (Wigfield & Eccles, 2000). Expectancy-value theory is one of the long-standing perspectives that theorists have endorsed and supported. Theorists in this tradition believe that individuals choose activities based on how well they believe they will perform the activity and the extent to which they value the activity. Eccles’ theory is based on the premise that educational and occupational expectations and aspirations, which guide individuals’
eventual educational and occupational choices, are influenced by three inputs: an individual’s expectations for success, self-perceptions of skills and abilities, and the values that an individual attaches to educational programs and occupations.

According to Eccles, Jozefowicz, Barber and Belansky (1993), Eccles’ model differed from contemporary models of educational and occupational attainment in vogue at the time in that it focused on choice rather than avoidance. Evidently other researchers, who also were studying women’s achievement related choices at the same time as Eccles, focused on why women avoided tasks as opposed to why they chose tasks. Eccles chose to concentrate on why women chose tasks because she believed a neutral model was needed to legitimize women’s choices, as opposed to other models that were used to compare women to an ideal male standard and to study why women chose not to achieve like men (Eccles, 1986). She posits that women’s decisions not to engage in an activity, such as enrolling in an engineering program, may reflect their choices of alternate activities or programs, rather than avoidance.

Eccles et al. (1993) points out that her theory differed from other contemporary theories not only because it focused on choice, but also because it considered the values that an individual embodies as playing a major role in making choices. Other models at the time that were being applied in the women’s achievement domain were predominantly self-efficacy theories, which included individuals’ self-perceptions and expectancies for success as primary constructs, but did not consider values. Eccles et al. (1993) posits that the values that individuals attach to doing well in different areas can play a key role in leading those individuals toward making a particular choice, and this is particularly true with regard to differences between genders in making educational and occupational choices.
Eccles’ theory provided a relevant lens through which the reasons why women choose to enroll in an undergraduate engineering program at a community college could be understood. The phenomena surrounding why some women do choose engineering was just as intriguing to this researcher as the mystery of why many women do not choose engineering was perplexing. According to Heyman, Martyna and Bhatia (2002), there is evidence explaining why men choose engineering, but the reasons why women choose engineering are not as clear. Eccles (1998) suggests that investigating what motivates women in terms of achievement can help us answer the question of “…why do women make the choices they do?” (p. 158).

Through Eccles’ expectancy-value lens, women may choose engineering because they have high academic self-perceptions and expectancies for success in the field, or it may be because of the value they associate with becoming an engineer, or a combination of both of these reasons. Of course, there may be other enrollment reasons that do not fit completely into Eccles’ theory. Nevertheless, researching the positive motivational dynamics surrounding women who do choose engineering is significant to the problem of the lack of women in engineering, because many recommendations that are being made on how to attract more women into engineering are based primarily on increasing women’s self-perceptions of their skills and abilities (Allison & Cossette, 2007; Eccles et al., 1993).

Eccles et al. (1993) posits that recruitment interventions based solely on improving women’s self-perceptions of their skills and abilities, in other words their academic self-efficacies, without regard to the other major construct in her model (subjective task values), will be ineffective. Eccles’s model can be used to provide the basis for designing more comprehensive interventions, such as how the field of engineering is portrayed to the general public, which might affect the value women assign to, and associate with, the work of engineers.
According to Matusovich and Streveler (2009), motivational theories such as Eccles’ have been used extensively in developmental educational and psychology research, but not nearly as much in engineering education research. They also relate that, although motivation has been used in a limited sense as a research construct in engineering education research, the engineering education literature surrounding motivation is for the most part not connected to any theoretical framework. They further suggest that future engineering education research could greatly benefit from connecting to motivational theories, especially achievement motivation theories such as Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices.

Achievement motivation can drive individuals to choose to engage or not engage in a task or activity, including studying for an exam or entering a college degree program. Through an achievement motivational lens, choosing to enroll in an engineering degree program can be considered an achievement-related activity because it is a reflection of a student’s self-confidence in his or her ability to meet the high academic demands of the program. Framed in Eccles’ (Parsons) et al. (1983) Expectancy-Value Theory of Achievement Related Task Choices, choosing to enroll in an engineering degree program also can be a reflection of the subjective value that a student places on becoming a professional engineer.

As applied to the choice of enrolling in an undergraduate engineering program, Eccles et al. (1993) explains that even women with strong academic skills and self-perceptions might not choose engineering, and instead choose occupations that pay less and that they consider to be less prestigious, because of the low value they place on becoming an engineer. Although women’s low self-perceptions of their technical skills and abilities might push some women from engineering, the higher values they may place on other occupations might also pull them
away from engineering. If engineering is perceived as an occupation that does not provide a good match with the values women hold, and other occupations are perceived as better matches, then even women with strong math and science skills and high expectations for success/self-efficacies might be drawn to other fields.

Ultimately, Eccles’ (Parsons) et al. (1983) theory is premised on the belief that individuals will choose those activities for which they feel most efficacious, have the highest expectations for success, and to which they attach the greatest value. There are two major constructs in the model, and they are personal efficacies/expectations for success and subjective task value; the latter being comprised of four components. The definitions and explanations of these two major constructs are provided below.

**Expectation for Success/Personal Efficacies Construct.** Expectancies for success and personal efficacies (confidence in one’s abilities) have a long history of being major constructs in decision and achievement theories (Eccles, 1987). Eccles (Parsons) et al. (1983) and Wigfield and Eccles (2000) define expectancy for success as an individual’s belief concerning how well he or she will perform on an upcoming task, and distinguish it from personal efficacies, which they say focus on ability beliefs associated with current competencies. These beliefs are arrived at over time by an individual’s life experiences and his or her interpretation of those experiences (Eccles, Barber & Jozefowicz, 1998).

For example, if a female student completes a difficult math course and receives a high grade, she might interpret her success as being attributed to lots of hard work. If she continues to work hard, she may have high expectancy for success in future math courses. On the other hand, she might interpret her success as being attributed to her belief that she is just simply gifted in math. This interpretation would be directly related to her having high academic self-efficacy.
**Subjective Task Value Construct.** Eccles (1987) explains that expectations for success and self-efficacies may not be sufficient conditions for achievement choices and therefore subjective task value is included as the second major construct in her model. She elucidates that academic decisions, such as course enrollments and selecting college majors, are influenced by the values individuals attach to the various achievement-related options that they perceive are available to them (Eccles, 1994). Similar to the expectations for success/self-efficacies construct, subjective task values are influenced by life’s experiences as well as cultural norms, and the behaviors and beliefs of one’s socializers, such as parents, peer groups and guidance counselors. She defines subjective task value as comprising four components, and they are: interest-enjoyment value, attainment value, utility value and relative cost. Eccles (2011) states that the attainment value and relative cost components “…are especially important for understanding the impact of gender roles on the value people attach to various activity choices” (p. 197).

**Interest - enjoyment.** The first component, interest-enjoyment, can be thought of in terms of the incentives associated with a particular choice. Eccles (1987) suggests conceptualizing it “…in terms of the immediate rewards, intrinsic or extrinsic, an individual derives from performing the task” (p. 148). She provides an example to further explain. If an individual truly enjoys mathematics, then choosing to study mathematics can be intrinsically rewarding to him or her. The choice to study mathematics can also be extrinsically rewarding in the form of praise from parents or teachers.

**Attainment value.** The second component, attainment value, is related to a person’s self-image of whom he or she is and whom he or she would like to be. Eccles (2011) posits that “Participation in a particular task requires the demonstration of the characteristics associated
with the task” (p. 197) and “…on the individual’s desire to demonstrate these characteristics both to him/herself and to others” (p.198). The example of how a woman might pride herself in being a caring, nurturing individual and see herself being employed in occupations that she perceives as complementing these attributes, and therefore choosing careers that she views as compatible with these characteristics is provided by Eccles (1987).

**Utility.** The third component, utility value, is the usefulness one assigns to a particular task, i.e., to what extent the task will assist one in reaching some desired end state. Wigfield & Eccles (2000) cite “…taking a math class to fulfill a requirement for a science degree” as an example of utility value (p. 72). An individual might not enjoy taking the math class, but he or she realizes that the completion of the course is necessary to graduate (Eccles & Wigfield, 2002).

**Relative cost.** Finally, the value placed on engaging in a certain activity can be affected by the perceived relative cost associated with that activity. Eccles (1987) suggests conceptualizing it in terms of emotional costs, as well as the cost of time and energy that potentially could be spent on other activities. Wigfield & Eccles (2000) explain relative cost through an example; specifically, how time spent completing schoolwork can limit time spent on the phone with friends. Since undergraduate engineering curricula can be demanding, the relative cost that students associate with coursework can affect enrollment and persistence.

**Gender, Perceptions of Gender Roles, and Gender Role Stereotypes**

Life’s experiences and cultural norms have influences on expectations, self-efficacies and values. According to Eccles (2011), gender role beliefs and identities in particular “…influence the options individuals consider in making life-defining behavioral choices” (p. 196). Individuals choose their major life roles only from the variety of options that they consider appropriate. Women may not consider the full range of objectively available options in making
their selections because they may be unaware that some options even exist. Eccles also points out that awareness for some options may exist, but these options are not seriously considered because women may have inaccurate information about the options. Other reasons why some options are not seriously considered include that women may believe they cannot achieve some options, or that some options do not fall within their gender-role schema.

Eccles (1987) provides an example of how self-efficacies and expectations can be influenced by gender role socialization and subsequently can affect women’s educational and career choices. Within an individual’s cultural milieu, gender role stereotypes such as the belief that women are less competent than men, can lead women to have less confidence in their own general intellectual abilities. Lacking confidence, many women may expect to either not succeed in traditionally male dominated fields, such as engineering, or to have to work much harder than men to achieve success in such fields.

**Limitations of the Study**

A qualitative study’s transferability, in other words the applicability of its findings to other contexts, is threatened when the study’s findings cannot be generalized beyond the immediate case study. Due to the small sample size in this research, generalizing findings to a larger population may not be reasonable, one may argue. However, the engineering program is typical of engineering programs offered at other community colleges nationwide and this study’s number of participants mirrors the national problem of the underrepresentation of females in engineering.
Chapter Two: Literature Review

The literature that focuses on the subject of the underrepresentation of women in engineering originates from a variety of disciplines, including but not limited to, education, government, psychology, social sciences and women’s studies. Researchers continue to seek the answers to why fewer women than men are engaged in engineering. Questions that were used in this research to select, analyze and organize existing research and theory were: *How have other researchers sought to understand the underrepresentation of women in engineering? How do women perceive the influences that motivated them to enroll in engineering? How is engineering portrayed and how do women perceive engineering? In what ways can community colleges attract and retain more women in engineering programs?*

With these questions in mind, a number of themes emerged from the literature review. The first theme centered on female high school students’ math and science preparation, and in particular, whether high school females are prepared for the academic challenges of college engineering programs. Researchers have investigated this strand in hopes of revealing whether a lack of adequate math and science preparation in secondary schools is a reason why there are so few women in engineering. Without adequate math and science preparation, women may have low expectancies for success. Expectancy for success is a major construct in Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices.

A second theme emerging from the literature review centered on gendered differences in cognitive abilities, in particular spatial reasoning skills; i.e., the ability to visualize objects in three dimensions (isometrics) and mentally rotate objects around different axes (orthographic projections). Researchers have studied whether young men are cognitively superior to young women, and therefore more likely to choose engineering in college. Students with superior
spatial reasoning skills might be more apt to choose engineering because they find it interesting and enjoyable more so than rigorous and challenging. Interest and enjoyment are components of the subjective task value construct in Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices.

The third theme focused on gender stereotypes and their effects on females’ self-efficacies. Self-efficacy is partnered with expectancy for success as a major construct in Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices. Researchers exploring this strand have illuminated how stereotypes can affect academic and occupational choices, as well as persistence, across genders.

The fourth theme involved how the field of engineering is portrayed to the populace. Some researchers have examined this area to determine whether engineering is misunderstood. They suspected that the manner in which the field of engineering is portrayed can affect the extent to which women identify with being an engineer. This group of literature directly relates to the attainment value component of the subjective task value construct in Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices. Included with this group of literature was how women describe the environment within academic departments and at engineering workplaces. Researchers have been examining potential barriers that women might face in STEM, which might affect academic enrollment, persistence and occupational choice.

Some of the literature focused on recruitment interventions that are intended to attract and retain more women in engineering. This group of literature emerged as the fifth theme of this literature review. It is a relevant topic in light of Eccles’ recommendation that recruitment
interventions should not be based solely on raising females’ self-confidence in STEM subject areas.

Finally, the literature review also revealed that engineering education research has been carried out primarily at four-year colleges and universities, with relatively little relevant research taking place at community colleges. The vital role that community colleges can play in increasing the number of women in engineering emerged as the final theme from the literature review and a discussion is included below.

**High School Math and Science Preparation**

Malicky (2003) undertook a national study to compare the high school backgrounds of first-year engineering undergraduate students. He concluded that the math and science backgrounds, across genders, were very similar in terms of the number and level of preparatory courses completed in high school. Recent data indicates that, in general, high school female students are just as academically qualified as male students to enter engineering programs in college (Shettle et al., 2007). In fact, according to that annually issued government report card on education, the total grade point average (GPA) for high school females was consistently higher than that of males during the 15 years between 1990 and 2005. Perhaps of greater relevance, that report also reveals that the grade point averages (GPAs) of female students in mathematics and science courses consistently had been higher than the males during those same years.

Even more recent statistics indicate that, in 2009, high school females earned on average the same number of course credits in mathematics and science as males and again had higher overall GPAs (Nord, et al., 2011). The data also reveals that the percentage of 2009 high school graduates who earned credits in calculus was the same, 17%, across genders. This data is relevant because undergraduate engineering programs typically require three or more semesters
of college level calculus, and high school mathematics preparation can give students an advantage in college and perhaps a higher expectancy for success.

Although data indicates that high school females are earning just as many math and science credits as males, Hill et al. (2010) report that there is a difference between genders with regard to test scores earned on the mathematics sections of high stakes tests such as the Standard Aptitude Test (SAT) and the American College Testing (ACT) exam. These exams can play a critical role as gatekeepers to four-year colleges, but generally are not required for admission to community colleges. Nevertheless, a recent report indicates that males consistently outscored females on the math portion of both of these tests during a ten-year period (Corbett, Hill & St. Rose, 2008). These lower test scores may be attributable to stereotype threats discussed in another section below. Interestingly, research does not identify these test scores as a major reason why there are so few women in engineering. The data suggests high school females seem to be just as academically qualified as the males to enroll in engineering programs in college.

Furthermore, recent news regarding high stakes test scores is encouraging. Hill et al. (2010) reports that the gender gap among the scores on the math section of the SAT is closing. Evidently, in the 1980’s there was a 13:1 ratio of the number of males as compared to females who scored above 700 out of a possible 800 points, and this has recently decreased to 3:1. Yet the percentage of women in engineering has remained relatively unchanged.

**Spatial Skills**

Some researchers have identified valid differences in cognitive abilities between genders, specifically those abilities related to spatial reasoning. As cited by Hill et al. (2010), Linn and Peterson (1985) found that men are better than most women at visualizing and mentally rotating three-dimensional objects. Agogino and Hsi (1995) similarly concluded that female
undergraduates lagged behind their male counterparts when faced with abstract concepts in engineering courses, such as orthographic projections and three-dimensional isometric views of machine parts. Sorby and Baartmans (2000) provide supporting evidence; the male undergraduates in their study outscored the female undergraduates on spatial reasoning tests that the researchers administered. Such superior skills can give students an advantage in some engineering courses, although research has not identified a clear connection between these skills and success in STEM careers.

Interestingly, Sorby and Baartmans (2000) found that some of the female participants in their study had excellent spatial reasoning skills. After further investigations, the researchers found that those female participants who scored high on the spatial reasoning test were the same ones who indicated they had childhood exposure to construction related toys. Subsequently, these researchers developed an introductory spatial visualization reasoning course, which they offered to undergraduate engineering students. Students who completed this introductory course as a prerequisite achieved much higher grades on the spatial reasoning test. Their findings suggest that spatial skills can be acquired in a short term.

This echoed what Agogino and Hsi (1995) concluded in their earlier study. They administered pre-tests to freshman coeds, followed by a spatial skills training course, and concluded with a post-test. After the spatial skills training course was completed by participants, their post-test scores were observed to be significantly higher than their pre-test scores.

Spatial skills have been identified as having positive effects on the gender schema of female engineering students. According to Cech (2005), if women see the role of an engineer as in conflict with their gender schemas, and therefore cannot see themselves as engineers, they are not likely to choose engineering as their career path. Cech (2005) studied the gender schemas of
successful female engineering students and found that most of them had childhood experiences that included tinkering with traditionally masculine toys.

Through the lens of Eccles’ (Parsons) et al. (1983) Expectancy Value Theory of Achievement Related Task Choices, the lack of spatial reasoning skills may serve as a deterrent for some women who are considering enrolling in engineering if it lowers their expectancy for success in engineering courses and increases the relative cost component of the subjective task value they place on engineering. On the other hand, strong spatial reasoning skills might attract women to engineering. However, there is not enough research that has proven either hypothesis. Nevertheless, spatial skills are considered important attributes for engineering students to have. For instance, the National Science Board, in one of its recent reports, describes young adults who have the potential to become STEM innovators as having mathematical and spatial abilities, alone or in combination with other aptitudes and factors (National Science Foundation, 2010).

**Stereotype Threat and Self Efficacy**

Some researchers blame negative stereotypes, such as the widespread stereotype that males are cognitively superior to females at math and science, for the lack of women in engineering. For example, Hill et al. (2010) indicates that when females are exposed to stereotypes threats and believe that they are true, they have less confidence in themselves than do females who disregard such stereotypes. Their lack of self-confidence has been shown to correlate with poor performance on math tests, lower expectations for success and the likelihood to disengage from STEM subjects. On the other hand, when females disregard such stereotypes, they are confident in themselves and are more motivated to learn. They believe they can become smarter through studying and working hard, and more likely to persist in STEM.
Females who disregard stereotype threats are described by some researchers as having an incremental or a malleable view of intelligence, as opposed to an entity or fixed mindset (Heyman et al., 2002). According to Hill et al. (2010), females who have a malleable view of intelligence perform better on math tests and are more likely to lean toward pursuing STEM majors in college.

Although such math/science stereotypes have been called “ancient and erroneous” (Hill, et al., 2010, p. 90), women’s perceptions of their own engineering aptitudes and abilities, in other words their engineering self-efficacies, whether or not influenced by stereotype threat, has been identified as a potential reason why there is a lack of women in engineering (Heyman et al., 2002; Hill et al., 2010). Malicky’s (2003) broad study reports that among first-year engineering students, females appeared to have lower self-efficacies than their male peers in STEM, and students with such low self-efficacies demonstrated a higher risk of attrition. He also reports that high self-efficacies among some women in STEM correlate very well to the positive influences of faculty and role models.

**STEM Portrayal and the STEM Environment**

Milgram (2011) posits that females “…need to receive the message that they can work in STEM careers and be successful and fulfilled in their work life while still having a personal life, and they need to receive this message repeatedly” (p. 5). Mattis & Sislen (2005) suggest that the reason why fewer female high school graduates pursue engineering may be attributable to such things as inadequate or nonexistent guidance counseling in high schools, a lack of advertising by colleges, and/or the absence of social role models and mentors. According to Blaisdell (2000), “Female high school students are often unaware of what engineering is, the variety of options within engineering, and the socio-economic benefits of being an engineer” (p.
Research has shown that women’s choice of major in college is more greatly influenced by family members and high school teachers as opposed to men’s choices’, and women majoring in STEM subjects have less of a clear understanding about their major or its career path (Malicky, 2003).

Eccles (1987) describes school counselors as being notorious for relying on pre-packaged brochures that provide students with gender-role stereotyped information about nontraditional careers. She reasons that this likely occurs because of the huge client loads placed on most school counselors, which prevents them from being able to provide more individualized counseling. The Goodman Research Group, Inc. (2002) indicates that high school guidance counselors are among the most likely to discourage females from pursuing a major in engineering. This is problematic in light of Blaisdell & Tichenor’s (2004) study that found that targeting interventions early, such as before or during high school, would be the most effective technique in recruiting more women into engineering.

The problem goes beyond guidance counselors, however. According to the National Academy of Engineering (2008), hundreds of millions of dollars are spent in the U.S. every year to improve the public’s understanding of engineering, yet most people have a poor understanding of the profession. The majority of people in general do not view engineering as directly benefiting individuals or society. This is a challenge for the engineering profession and is compounded by Eccles’ (2011) finding that women tend to choose careers that they perceive as contributing more value to society.

Eccles and her colleagues have posited that one of the main reasons that women may not choose engineering as often as men do has to do with their perceptions of the jobs; i.e., their perceived task value. Women may hold the belief that engineering jobs do not fit very well with
the types of jobs they would like to have. They may view engineering jobs as incompatible with their goals of wanting to be very involved with their families and raising children (Bembenutty, 2008). Eccles (2007) found that both men and women who choose engineering place low value on having a job that directly benefits other people or society. A later article by Eccles (2011) provides evidence that suggests women place more value than men do on the importance of making career sacrifices for one’s family and are more likely to choose occupations that are concerned with helping people and society. She also provides evidence that suggests men are less person-orientated than women, and place more value on manipulating objects and understanding the physical world. Hill et al. (2010) similarly concludes that women are more likely than men to choose academic programs and occupations that provide a clear social purpose.

Matusovich, Streveler and Miller (2010) applied Eccles’ expectancy-value theory in their study of undergraduate engineering students enrolled at a public four-year college and found that the women demonstrated a greater perceived lack of fit with their degree program than the men. These researchers explain that such perceived lack of fit, or in other words a lack of connection between engineering and how they see themselves, is closely related to the attainment value construct in Eccles’ expectancy-value theory. They suggest that students’ low attainment values may affect their persistence in engineering. They advise that women might be encouraged to remain in their engineering degree program if they can identify with being an engineer.

The STEM environment within college departments and at the workplace can also deter women from entering and persisting in engineering. This is relevant because women who may be considering enrolling in engineering may learn about engineering through other women who precede them in college. The literature cites the unsupportive and unwelcoming culture of
engineering as an explanation for the underrepresentation of women in engineering (Hill et al., 2010).

According to Malicky (2003), women have described the engineering climate as “chilly”. He cites evidence that supports differential discrimination against women in engineering. Heyman, et al. (2002) similarly reports that women tend to perceive the climate of engineering schools as intimidating, uninviting and non-supportive. Janigan and Masemann (2008) suggest that bias in teaching may be a cause. It may be that some women may be uncomfortable in a college classroom or lab setting where they are the only female. It also has been reported as well that the first two years of undergraduate engineering education is perceived by many to be very competitive and a time when faculty and administrators try to weed out students with low grades (Mattis & Sislen, 2005).

**Recruitment Interventions**

Allison and Cossette (2007) posit that many practices that are commonly employed to recruit women into STEM careers are based almost exclusively on raising girls’ interest in STEM. They refer to “interest inventories” as an example, and these often are common in the form of on-line questionnaires. They also cite practices such as field trips, pamphlets, talks, demonstrations and observations of someone at work, as further examples of recruitment practices that are based primarily on raising female students’ interest in STEM careers.

Blaisdell and Tichenor (2004), suggest that colleges focus on recruiting females who already have an interest in engineering, rather than on trying to create interest in engineering. They claim that if colleges want more women in their engineering programs, they “…must either compete or create” (p. 1). By competing, they suggest actively pursuing the few women who have a preexisting interest in engineering, whereas by creating they suggest investing resources
in programs that will attract those women to their schools. In an earlier article, Blaisdell (2000) criticizes recruitment interventions that have primary goals of raising female students’ academic self-confidence, and posits that interventions should instead focus on discovering what females want to accomplish from a career and then demonstrating how engineering can fulfill those values.

Allison and Cossette (2007) identify aptitude tests as examples of recruitment practices commonly employed, and they suggest that such tests are grounded primarily on measuring females’ math and science abilities. They claim that aptitude tests have long been used to guide students toward or away from engineering and that scores on these tests can deflate students’ academic self-efficacies and expectancies for success in engineering. They offer suggestions for recruitment practices that they posit are not based solely on interests or aptitudes. For instance, they suggest using hands-on workshops, during which females are allowed to work collaboratively rather than competitively, as a way of increasing their confidence. They also stress the importance of showing females the practical utility of STEM careers; i.e., the relevance of STEM to everyday life. Blaisdell (2000) similarly recommends that in order to increase the number of women in engineering, interventions should focus on “…increasing girls’ positive expectations of what an engineering degree would do for them” (p. 248). These recommendations fit well into the subjective task value construct of Eccles’ (Parsons) et al. (1983) Expectancy Value Theory of Achievement Related Task choices and therefore these researchers seem to be in agreement with Eccles; i.e., that interventions that are based solely on interest, ability and /or efficacy may be ineffective recruitment strategies.

Milgram (2011) opines that there is no secret to recruiting females into STEM classrooms. Females “…need to receive the message that women can work in STEM careers and
be successful and fulfilled in their work life while still having a personal life, and they need to receive this message repeatedly” (Milgram, 2011, p. 5). Cech (2005) recommends that in order to make headway in recruiting more female engineers, the popular image of both the woman and the engineer must be challenged. These recommendations also complement what Eccles (1987, 2011) suggests, particularly with regard to gender, gender roles and gender role stereotyping.

Eccles (1986) writes,

Women’s (and men’s) perceived career options can be increased by programs targeted to their beliefs that train them to (1) associate different attributions and expectations with various occupations, (2) assess the value they attach to occupations, (3) reevaluate their stereotypes of various occupations and life-roles, and (4) reassess the compatibility between various career options and one’s adult-role plans. (p.19)

She posits that, to be most effective at preparing females for making wise career choices, career counseling programs should incorporate all four of these components. Eccles (1986) suggests that engineering programs need to do strenuous outreach through the internet because the web is so popular with young people (Bembenutty, 2008).

Costello (2012) highlights practical, social and financial recruitment interventions, such as how community colleges can offer on-campus childcare programs to attract low-income women and student parents. She also describes college programs that offer innovative coursework, such as on-line learning and developmental courses that integrate basic skills with professional technical skills, as being successful in recruiting additional women in engineering.

However, Malicky (2003) reports that interventions that focus on recruitment alone have resulted in disappointing outcomes. He suggests that recruitment activities whose mission is solely to search for undiscovered talent cannot succeed if they do not address the potential
barriers that women may face once they enroll in engineering. He posits that recruiting women into unfriendly and sometimes hostile environments is even unethical. He proposes that recruitment interventions should not be undertaken until women’s experiences in engineering are fully understood.

The term “pipeline” has been commonly used in the literature as a metaphor to describe the path to arriving at an engineering degree, with male and female students comprising the “fluid” in the pipeline. Malicky (2003) applies an engineering analogy to the flow in the pipe and how to increase the number of women in it. He suggests that in order to increase the flow in the pipe, engineering departments have two choices: to apply more pressure to the supply side of the pipe or to increase the diameter of the pipe. He posits that applying more pressure to the supply side of the pipe will result in excess stress and strain on the pipe and potential leaks. Increasing the diameter of the pipe, on the other hand, will allow for greater flow, but conversely it will also result in additional costs associated with requiring the new, larger pipe. He uses this interesting analogy to suggest that interventions should not just push more fluid (women) into the pipeline (engineering) without a simultaneous change in the pipeline itself.

The Role of Community Colleges

The chairman of the National Science Board, in his statement to the U.S. House of Representative’s Committee on Science and Technology, described the critical importance that STEM education has to this nation and revealed a national action plan to address its shortcomings (Beering, 2007). One of the steps highlighted in the action plan is a recommendation to promote horizontal and vertical alignment of STEM education across grade levels, from pre-kindergarten through the first year of college. One of the specific recommendations is to improve the linkage between high school and higher education.
The engineering transfer option that many community colleges offer can play a vital role in producing more women engineers. Little research to date has explored the experiences of women in STEM programs at community colleges and the factors that can hinder or promote their success (Costello, 2012).

According to Mooney and Foley (2011), 38.3% of recipients of bachelor’s and master’s degrees in engineering in the 2006/2007 academic year reported ever attending a community college. The two most frequently reported periods of attendance were: 1) while simultaneously enrolled in a four-year college and before earning a bachelor’s degree and 2) after high school but before enrolling in a four-year college or university. The top reason reported by participants in their survey for attending a community college was to earn credits that could be applied toward a bachelor’s degree. Other reasons for attending, in order of popularity, were found to be for financial reasons, for the hope of increasing chances of acceptance to a four-year college or university, and to gain engineering skills or knowledge.

Mattis and Sislen (2005) indicate that transfer students who have earned an associate’s degree in engineering at a community college are just as likely to receive a bachelor’s degree in engineering as students who began their programs at the four-year colleges. A majority of representatives from four-year colleges that participated in a National Academy of Engineering workshop on community college engineering transfer programs reported that “…transfer students were as well prepared or better prepared than four-year only students and that the retention rate for transfer students was the same or higher than for four-year only students” (Mattis & Sislen, 2005, p.11).

However, it also has been reported that many students are not aware that they can earn the first two years of a bachelor’s degree in engineering at a community college (Mattis &
Sislen, 2005). Evidently, there is an erroneous perception that a community college degree is a capstone degree and that the path to a bachelor’s degree in engineering is a separate endeavor.

Jackson and Laanan (2011) studied the experiences of women who did start their degree path in STEM programs in the community college system and then later transferred to a four-year college. They found that the women in their study considered the community college environment as intellectual and comfortable, but did not feel the same level of comfort at the four-year institutions. A large majority of the women participants agreed somewhat, or agreed strongly, that the community college’s courses were intellectually challenging and prepared them well for the university level courses, but reported that they did not feel as comfortable approaching their instructors with questions at the four-year institutions.

**Conclusion**

The above literature review has revealed that a number of researchers have investigated the mystery of why women are underrepresented in engineering as compared to men. Researchers have looked at the problem from a variety of perspectives. They have analyzed statistics concerning the academic preparedness of high school female students, compared cognitive abilities across genders, studied stereotype threats and their effects on females’ self-efficacies, critiqued how STEM is portrayed, and investigated the role of community colleges in producing more engineers.

Researchers who have analyzed statistics have found that high school females are just as academically qualified as males to enroll in engineering undergraduate programs, based on the extent of high school courses completed in STEM subject areas and the grades achieved. Their findings suggest that there are other reasons beyond academic preparedness that may explain why fewer high school females than males choose to major in engineering in college.
Researchers who have compared cognitive abilities across genders point to spatial reasoning skills. These researchers have found that females tend to be less skilled than males in spatial reasoning, for instance in the ability to mentally rotate three-dimensional objects around axes. They infer that some engineering courses rely on students’ abilities to visualize objects in three dimensions, and if females are aware of this, they might not choose to enroll in engineering if they have not developed their own spatial reasoning skills. However, research does not indicate that this is a primary or major reason why there are fewer women than men in engineering. Furthermore, the literature reveals that individuals in need of sharpening their spatial reasoning skills have been able to do so relatively easily through training.

A number of other researchers have investigated gender stereotypes, such as the evidently widespread belief that males are better than females in math and science, and the influences that such negative stereotype threats can have on girls’ academic self-confidence. These researchers have suggested that females shy away from engineering because they lack self-confidence, and their lack of self-confidence may be attributable to stereotype threats and gendered socialization.

Another strand of research related to stereotypes involves how the field of engineering is portrayed by colleges, the government and professional societies. Researchers have indicated that women might perceive engineering as primarily a masculine profession and have suggested that engineering may be in need of a marketing overhaul if the goal is to attract more women to the field. Some of these same researchers have suggested that, in addition to gendered occupational stereotypes, some women perceive the engineering environment within undergraduate engineering programs and at the workplace as unwelcoming toward women.

Researchers have also highlighted recruitment interventions aimed at attracting more women into engineering. Researchers posit that recruitment interventions that are not grounded
in a sound theoretical framework will not be effective in attracting and enrolling more women in engineering. For example, Eccles (1993) warns that recruitment interventions that rely solely on increasing females’ self-confidence will not be as effective as interventions that also consider the subjective values that women associate with achieving an engineering degree.

This theme led into the final issue emerging from the literature review, specifically, what role community colleges can play in attracting and retaining more women in engineering. A number of researchers have identified community colleges as a potential gateway to engineering for women, yet they indicate that little research on the experiences of women enrolled in two-year engineering programs has been completed (Beddoes & Borrego, 2011; Cech, 2005; Costello, 2012; Gill et al., (2008); Starobin & Laanan, 2005; Starobin & Laanan, 2008).

Costello (2012) identifies a number of questions that remain to be answered regarding the experiences of women in STEM programs at community colleges. One question she proposes is whether more female role models would attract more women into STEM programs. Another question she proposes points to whether women see STEM fields as too demanding, and incompatible with their desire to balance family and work life. Both of these questions are directly related to the attainment value component of the subjective task value construct in Eccles’ (Parsons) et al. (1983) Expectancy Value Theory of Achievement Related Task Choices, as well as to the research questions posed in this proposal.
Chapter Three: Research Design

According to Yin (2003), “…a research design is a logical plan from getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions” (p. 20). The research design includes the research questions and methodology concerning research strategy, participant and site selection, data collection and data analysis.

Research Questions

The two research questions that guided this researcher’s analysis of empirical data were:

1. How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering?
2. How do women perceive their subjective task values as influencing their decisions to enroll in engineering?

The purpose of these two research questions, which inquired about women’s perceptions of the influences upon their choice of academic major, was to understand how the participants became motivated to enroll in engineering. The fact that some women do choose engineering is intriguing, and having gained an understanding of their beliefs will be very useful in the design of future recruitment interventions at community colleges nationwide. The information gained through this research will also be invaluable in assisting women in making more informed academic choices.

Through the lens of Eccles’ (Parsons) et al. (1983) Expectancy Value Model of Achievement Related Task Choices, women choose academic majors with which they associate strong self-efficacy, high expectations for success, and personal values. Figures 3.1 and 3.2
depict a simplified map of Eccles’ theoretical model and how it can be applied in the domain of choosing to enroll in an engineering degree program, respectively.

**Figure 3.1.** The two major constructs in Eccles’ et al. expectancy-value theory.

**Figure 3.2.** Simplified View of Eccles’ expectancy-value theory.

Eccles (1993) posits that recruitment interventions should not be based solely on increasing young women’s self-efficacies. She suggests that women might choose non-
traditional careers, such as engineering, for other reasons besides their academic skills and self-efficacy. She has found that women tend to place more emphasis on the importance of helping other people and society, than on prestige and status.

The research questions in this study were both process questions, which Maxwell (2005) defines as questions that focus on how things happen, in contrast to variance questions, which focus on determining whether one variable is related to another variable and to what extent. The two research questions together focused on how and why women are drawn to engineering from their own perspectives, and involve situation-specific phenomena.

**Methodology**

The two primary research methods that are currently used in the education and social science areas are qualitative and quantitative (Creswell, 2009). Qualitative research tends to focus on specific situations or people and, unlike quantitative research, emphasizes words rather than numbers. Each of the two methods has different strengths and logics and each lends itself to address different kinds of questions and goals (Maxwell, 2005). Qualitative researchers tend to be interested in understanding processes such as “…how x plays a role in causing y…” as opposed to quantitative researchers who tend to be interested in “…to what extent variance in x causes variance in y” (Maxwell, 2005, p. 23).

This researcher’s practical and intellectual goals were best suited for a qualitative research model. According to Maxwell (2005), qualitative studies are especially well suited for research that aims to understand the particular contexts within which the research participants act, and the influence these contexts had on the participants’ actions. The in-depth qualitative data that was examined through this research may influence administrators at other community colleges, as well as teachers and counselors at secondary schools, in their efforts to support and
enhance the community college pathway to engineering degrees and careers for women. It was important to identify and understand the motivational factors that had influence on women’s enrollment decisions, in order to provide data and insight that will enable more informed recruitment and retention efforts at community colleges nationwide. Qualitative data has shed light on the complex mechanisms of academic and career choice.

**Research Tradition.** According to Yin (2003), the type of practice based research that provided the best fit with this researcher’s questions was case study research. “Case studies are the preferred strategies when “how” or “why” questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context” (Yin, 2003, p. 1). Similar to other research strategies, such as experiments, surveys, archival analyses and histories, case studies are empirical inquiries. Yin (2003) points out that experiments and histories can also lend themselves to answering how and why questions; however, case studies are preferred when the investigator has little control over and access to behavioral events. He explains that experiments are usually chosen as a research strategy when the investigator wants to deliberately manipulate behaviors, and histories are the typical research strategy undertaken when there is virtually no access to or control over events.

According to Yin (2003), there are four basic types of case study designs and he refers to them as single-case holistic, single-case embedded, multiple-case holistic and multiple-case embedded designs. Of those four, this research leant itself well to a single-case holistic design, with one unit of analysis, for reasons described below.

The perceptions of female students who had graduated from an undergraduate, two-year engineering degree program constituted this single, holistic case study and these students served as the single unit of analysis. Yin (2003) provides five rationales in which a single-case study is
appropriate. This research met Yin’s third rationale in that the engineering program at the proposed research site is representative and typical of the majority of two-year engineering programs at other colleges. The research objectives were to capture the circumstances and conditions leading up to the participants’ choices to enroll in this typical two-year engineering degree program. Also according to Yin (2003), the holistic design as opposed to an embedded design is advantageous when the case study seeks to examine “…the global nature…” of the program (p. 43).

**Site and Participants.** This research was conducted at a community college in the northeastern United States. This college was founded in 1965 and offers an associate level degree in engineering. Under that engineering degree program, students may choose between two main academic tracks to follow - the technology and transfer tracks, respectively. The engineering technology track, also known as the career track, prepares graduates to enter the engineering profession directly after earning their associate degree, whereas graduates of the transfer track delay entering the workforce. Instead, they are academically prepared to transfer directly to a four-year engineering school to pursue higher level degrees. Both tracks offer students the opportunity to concentrate their elective courses in a variety of engineering specializations including architectural, civil, electrical, manufacturing, mechanical and structural engineering.

Participants were purposefully drawn from both tracks and consisted of four female students who had graduated from the college with an engineering degree. This group of four female engineering graduates formed the single unit of analysis. The investigation centered upon their perceptions of their academic choice, particularly the factors and contexts that they considered as vital towards leading them to choose engineering as a college major.
In qualitative research, the common way of selecting research sites and participants differs from how research sites and participants are selected in quantitative research (Maxwell, 2005). In qualitative research, sites and participants are typically selectively chosen rather than randomly chosen, and the selection method is referred to by a variety of terms by scholars including *purposeful selection, purposeful sampling* and *criterion-based selection* (Maxwell, 2005). The deliberate selection of research sites and participants enables data to be collected that may not be directly drawn from random sources. Some qualitative studies do lend themselves to random sampling, particularly studies with large sample sizes, in which stratified random sampling can be used to avoid the perception of favoritism in selecting interviewees (Maxwell, 2005). This research did not include a large sample size because there was not an abundance of female engineering students from which to draw upon, which reverts to the very problem that this research sought to address.

Some scholars are critics of selective sampling of sites and participants. For instance, as cited by Maxwell (2005), Light, Singer and Willet (1990) discourage deliberate site and participant selection, calling it convenience sampling, and contrasting it to the paragon of high-quality research that incorporates random site selection and samples. However, Maxwell (2005) posits that selective sampling is not the same as convenience sampling. He cites, as an example, interviews, which are commonly used in qualitative studies as a means of data collection, and draws an analogy between interview participants and panels of experts. The interviewees are uniquely qualified to provide information to answer research questions because they are experts in an area, according to Maxwell (2005). The sampling method used in this study achieved two goals that Maxwell (2005) deems as important for purposeful selection, first to deliberately
examine cases that are critical for the theory that frames a study and second, to achieve representativeness or typicality of the individuals chosen.

**Data Collection.** Yin (2003) discusses the importance and purpose of triangulating case study research. Triangulation will result in the research having more convincing and accurate conclusions and can be accomplished by using multiple sources of data, researchers, theories and/or methods. This case study research used three data sources to support the findings – a questionnaire, individual interviews and a focus group meeting.

The rationale for choosing to use a questionnaire as a data source was that it allowed the participants to provide written, thoughtful responses to questions, in a personal and private setting of their choice, with no immediate time constraints. Interviews were considered an appropriate data source because case studies focus on human affairs which “…should be reported and interpreted through the eyes of the participants” (Yin, 2003, p. 92). The focus group was chosen to triangulate the data.

The questionnaire was the first instrument used to collect data and was distributed through email to all four participants. The questionnaire consisted of ten open-ended, non-leading questions. The questions were open ended, to encourage the participants to provide full, meaningful answers based on their own knowledge and/or feelings, and non-leading, to avoid responses that were false or slanted.

Next, individual, semi-structured interviews were held during which follow-up open-ended questions were posed to each participant. Each interview lasted about one hour. A semi-structured interview format was used because, although this researcher had a general framework of themes to be explored, it provided the participants the freedom to divert from the rigor of a set of questions, allowing new themes to emerge. Each interview was recorded, with the permission
of each participant, which allowed repeated access to the data. The semi-structured interviews served to further probe the participants concerning their responses to the questionnaires, helped to achieve converging lines of inquiry and corroborated the researcher’s interpretations of the questionnaire responses. The interviews also provided opportunities for the participants to further elaborate on their questionnaire responses to provide deeper explanations and clarifications.

A one hour, semi-structured focus group meeting with the participants was the final instrument used to collect data. This focus group meeting was also recorded to allow repeated access to the data. Similar to the interviews, the focus group meeting facilitated direct access to the participants and allowed the researcher to further corroborate the patterns established from the analyses of the completed questionnaires and interviews with the participants. It also provided opportunities for the participants to compare and contrast their individual experiences with the other participants. This led to the establishment of camaraderie among the group members and seemed to nurture participants’ further reflection and understanding of their individual choices to enroll in engineering, ultimately leading to the collection of very rich research data.

**Data Analysis.** Relying on theoretical propositions, which is one of the four general strategies that Yin (2009) recommends for analyzing case study data, and the one that he describes as the “most preferred strategy” (p. 130), shaped the data analysis of this research. Yin (2009) also discusses five specific techniques for analyzing case study data and the one that he describes as “the most desirable” (p. 136) is pattern matching logic. Such logic compares empirically emerging patterns with predicted patterns, according to Yin (2009). Pattern matching was used in this research to compare emerging patterns with the theoretically
suggested ones, which were defined by the components of Eccles (Parsons) et al. (1983) expectancy-value theory.

The data was codified according to Saldaña (2009) in more than one cycle. In analyzing the data, Saldaña’s (2009) affective methods category of first cycle coding was applied, in particular his values coding. According to Saldaña (2009), values coding is particularly appropriate for qualitative studies such as this, “…that explore cultural values and intrapersonal and interpersonal participant experiences and actions in case studies” (p. 90). Saldaña (2009) defines values coding as “. . . the application of codes onto qualitative data that reflect a participant’s values, attitudes, and beliefs, representing his or her perspectives” (p. 89). Saldaña (2009) defines values as the importance an individual attributes to herself, another person, a thing, or an idea, attitudes as the way that person thinks about those people, things or ideas, and beliefs as the individual’s interpretive perceptions. The initial codes that were applied during the first cycle of coding were single words and short phrases that represented and captured each data set’s content and essence.

The first cycle codes were reviewed and recoded before the second cycle was begun, to reorganize and reconfigure the first cycle codes into categories, themes or concepts as recommended by Saldaña (2009). Saldaña’s (2009) pattern coding was the second cycle coding method appropriate for this single case study. Saldaña (2009) discusses five other second cycle coding methods, but he advises that they are either used for developing grounded theory or to build upon a previous study’s codes.

**Trustworthiness**

Similar to quantitative research, which is typically judged on the basis of its reliability and validity, the rigor of qualitative research is examined on the basis of its trustworthiness.
Guba’s (1981) model for assessing the trustworthiness of qualitative data is one commonly employed model appropriate for application in education research. Lincoln & Guba (1985) and Miles & Huberman (1994) posit that the trustworthiness of qualitative research involves establishing credibility, transferability, dependability and confirmability.

**Internal Validity/Credibility/Authenticity.** A qualitative study’s credibility, in other words confidence in the truth of the study’s findings, is analogous to the internal validity of a quantitative report. A quantitative study’s internal validity is threatened when the researcher makes inferences concerning the data that has been collected. Lincoln & Guba (1985), Miles & Huberman (1994) and Yin (2003), suggest triangulation as a technique that can be used to establish a qualitative study’s credibility. A major strength of a case study strategy is the opportunity to use many different sources of evidence because there is an opportunity to triangulate the data (Yin, 2003). In this research, triangulation was achieved through the use of three sources of data – the questionnaire, interviews and focus group meeting. Triangulation occurred when the three data sources were used to corroborate facts and help yield converging conclusions.

Lincoln & Guba (1985) additionally suggest employing a member checking strategy, which Maxwell (2005) points out is sometimes called respondent validation. This researcher employed member checking during the focus group, to solicit feedback from the participants concerning the researcher’s interpretations. Miles & Huberman (1994) discuss the use of “…context-rich and meaningful (“thick”) descriptions…” (p. 279), as well as linking the data to the categories of prior theory, to enhance credibility. Thick descriptions were incorporated in this study and involved ensuring that data was thoroughly collected in sufficient detail, through recordings and written verbatim transcriptions of conversations. Thick descriptions allowed
repeated access to the data, made unnecessary any sole reliance on notes jotted down during the interviews and focus group meeting, and enabled the data to be linked to Eccles’ (Parsons) et al. (1983) theory.

**External Validity/Transferability/Fittingness.** A qualitative study’s transferability, in other words the applicability of its findings to other contexts, is analogous to a quantitative study’s external validity. A study’s transferability is threatened when the study’s findings cannot be generalized beyond the immediate case study. Due to the small sample size in this research, generalizing findings to a larger population may not be reasonable, one may argue. However, the engineering program is typical of engineering programs offered at other community colleges nationwide and the study’s number of participants is representative of the national problem of the underrepresentation of females in engineering.

Lincoln & Guba (1985) and Miles & Huberman (1994) suggest incorporating thick descriptions to achieve transferability, enabling readers to assess the appropriateness for their own settings. As discussed above, the use of thick descriptions, sometimes also referred to as dense or rich descriptions, is a strategy that was incorporated in this study and it involved ensuring that data was thoroughly collected in sufficient detail, through recordings and written verbatim transcriptions of conversations. They also enabled the evaluation of the extent to which the findings are transferable.

**Reliability/Dependability/Auditability.** A qualitative study’s dependability is analogous to a quantitative study’s reliability. Reliability refers to whether another researcher would arrive at the same conclusions as this researcher, if that later researcher repeated this case study exactly. Miles & Huberman (1994) describe this as “quality control” (p. 278) and suggest it is threatened
when procedures are not documented. Developing a database and documenting all data were
tactics that were incorporated in this study, as Yin (2003) advises.

In addition to documenting all data, this qualitative study’s dependability was enhanced
through the coding-recoding process (Guba, 1981; Lincoln & Guba, 1985; Miles & Huberman,
1994). When data was initially coded, it was recoded after a reasonable amount of time had
elapsed to check for accuracy and enhance dependability.

Objectivity/Confirmability. A qualitative study’s confirmability can be compared to a
quantitative study’s objectivity. This describes the extent to which a study’s findings are
influenced by researcher bias, motivation or interest (Lincoln & Guba, 1985). Maxwell (2005)
not only warns about researcher bias, but also reactivity; the latter being the effect that the
researcher may have on the participants. Miles & Huberman (1994) suggest that researchers be
as explicit and self-aware as possible about personal assumptions and biases and how they may
affect a study.

This researcher was aware that her professional ties to the community college’s
engineering department may have affected participant responses, since the participants graduated
from the engineering program. The researcher teaches engineering classes, in which some of the
participants had previously been enrolled when they were students in the program. The
researcher also acknowledged that she has an interest in continuing to head a healthy and
rigorous engineering program. The researcher is also female, as were the participants, and may
have had preconceptions regarding women in engineering and the choices they’ve made.

The researcher allowed the participants to choose the locations for the interviews and
focus group meeting to mitigate any potential of the participants feeling intimidated and to
enhance the potential of the participants providing honest answers to questions. Besides being
explicit and self-aware of inherent biases, this researcher minimized bias by avoiding leading questions during data collection.

**Utilization/Application/Action Orientation.** Participants may have benefited from their participation in the study because the focus group meeting provided them with the opportunity to meet other female engineering graduates that they previously may not have known. This enabled them to have an opportunity to share experiences as female engineers and to professionally network. Potential benefits to the field of engineering have occurred because the data has shed light on the complex mechanism of academic choice. More informed recruitment strategies for women in engineering may result.

**Protection of Human Subjects**

This research involved collecting data from human subjects. Creswell (2009) emphasizes the need for researchers to “…protect their research participants, develop a trust with them, promote the integrity of the research, guard against misconduct and impropriety that might reflect on their organizations or institutions, and cope with new challenging problems” (p. 87). The research plans were reviewed and approved by the Institutional Review Board (IRB) of the research site and Northeastern University. Federal regulations mandate the existence of IRB committees to protect against human rights violations.

No ethical dilemmas arose from this research. The participants’ rights of confidentiality and safety were honored; all participants in this study were required to sign a release form indicating their voluntary consent to participate. The consent form explained that the participants’ rights were protected during data collection, as recommended by Creswell (2009).
All participants were assigned pseudonyms for the duration of the research. All data has been electronically and securely stored by the researcher in electronic files on a personal computer, which is password protected, and the files will be destroyed after six months.

**Conclusion**

This research aimed to investigate and contribute to the current knowledge surrounding the problem of the lack of women in engineering, by collecting and analyzing qualitative data from females who graduated from a two-year engineering program at a community college in the northeastern U.S. The literature review revealed that, although much is known about why men choose engineering, little is known about the academic choices women make. In addition, most research surrounding the underrepresentation of women in engineering and their academic choices has occurred at secondary schools and four year colleges and universities. Existing research has not adequately addressed why women who enroll at a community college choose engineering. An understanding of women’s choices to enroll in engineering will be useful in the design of future recruitment and retentions efforts.
Chapter Four: Report of Research Findings

Purpose of the Study

The purpose of this study was to research the positive motivational dynamics that women perceived as having influenced them to choose engineering as their academic major at a community college. Knowing why women chose engineering may help secondary and higher education institutions in their endeavors to motivate more women to choose engineering.

National data reveals how women historically have been underrepresented in undergraduate engineering programs in colleges across the entire country (National Science Foundation, National Center for Science and Engineering Statistics, 2011). In fact, the underrepresentation of women in engineering is a global phenomenon (Gill, Sharp, Mills, & Franzway, 2008).

Women who forego engineering as an academic choice are missing opportunities to earn rewarding salaries that science, technology, engineering and math (STEM) professions typically provide, and to contribute their personal and professional expertise toward the many specific disciplines within the field of engineering (Beede et al., 2011; National Science Foundation’s Division of Science Resource Statistics, 2011). The absence of women in engineering also is a missed opportunity for the engineering profession because engineers ultimately try to benefit other people and therefore the profession can only gain if its workforce is as diverse as the people that it serves (Chubin, May & Babco, 2005; Milgram, 2011). Women represent an untapped knowledge resource and could contribute greatly toward the engineering challenges of these times (Beede et al., 2011; Beering, 2007; Blaisdell, 2000; Blaisdell & Tichenor, 2004; Hill, 2010; Janigan & Masemann, 2008).
**Research Central Questions**

Two central research questions guided this study and the process that governed the formation of these questions is shown graphically in Figure 4.1.

![Research Questions Diagram]

*Figure 4.1 Process governing formation of research questions*

The two central research questions were:

1. How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering?

2. How do women perceive their subjective task values as influencing their decisions to enroll in engineering?

Academic self-efficacies/expectations for success and subjective task values constitute the two main constructs of the theoretical framework in which this research is grounded, namely Eccles (Parsons) et al. (1983) Expectancy-Value Theory of Achievement Related Task Choices. The subjective task value construct has four subcategories, and these are interest-enjoyment value, attainment value, utility value, and relative cost.
**Research Site**

This research was conducted at a community college in the northeastern United States. The community college, founded in 1965, offers an associate level degree in engineering. Under that engineering degree program, students may choose between two main academic tracks to follow - the technology and transfer tracks, respectively. The engineering technology track, also known as the career track, aims to prepare graduates to directly enter the engineering profession upon graduation. The transfer track, on the other hand, aims to academically prepare graduates to transfer to a four-year engineering school to pursue a higher level degree.

**Research Participants**

Participants were purposefully drawn from the list of female graduates who had graduated from either engineering track within the past six years. The purposeful selection of the participants enabled data to be collected that may not have been obtainable from random selection.

Some scholars are critics of purposeful selection of sites and participants, calling it convenience sampling, and contrasting it to the paragon of high-quality research that incorporates random site selection and samples (Maxwell, 2005). However, Maxwell (2005) posits that purposeful sampling is not the same as convenience sampling. He explains how participants can be uniquely qualified to provide information to answer research questions because they are experts in an area. The research participants in this study were uniquely qualified to answer the research questions posed to them because they were female and chose engineering, and therefore they were purposefully selected.

Because there was not a substantial number of female engineering graduates from which to draw, which points back to the very problem of the underrepresentation of women in
engineering, this research included a small sample size. Originally, the intent was to recruit all female students who graduated from the engineering program at the community college during the past three years, through an email invitation to participate in this study. However, data indicated that there were very few female engineering graduates during those three years. To expand the potential number of willing participants the criteria was extended, with the approval of all associated internal review boards, to include all female engineering graduates who had graduated within the past six years. Still, there were only 20 female engineering graduates during this time period to recruit.

Fortunately, four of the 20 responded to the solicitation and agreed to participate. This equated to a 20% response rate, and these four participants represented both the technology and transfer tracks of the engineering program offered by the community college. The invitation to participate, which was emailed to all 20 potential participants, is included in Appendix A.

**Participants’ Relevant Characteristics.** For the purpose of protecting the four participants’ identities, they were assigned pseudonyms “Cathy”, “Kerri”, “Mary” and “Lois”.

**Cathy.** Only one of the participants, Cathy, entered the engineering program directly out of high school and was the only one who graduated with an engineering transfer degree, as opposed to an engineering technology degree. Upon graduating, she transferred to a four-year college where she earned her Bachelor of Science degree in mechanical engineering. Cathy graduated from a vocational high school where she studied drafting. Reflecting on her decision to enroll in the community college, instead of enrolling directly in a four-year college, she said that she perceived the community college environment as “small” and “welcoming”, and drew analogies to the vocational high school that she attended and at which she evidently thrived.
Kerri. Similar to Cathy, Kerri enrolled at the community college directly after graduating from high school, but unlike Cathy, she enrolled in a secretarial science program and not immediately in engineering. After attending classes in secretarial science for three semesters, she withdrew from the college, but thirteen years later returned as a full-time student in engineering technology. Although she graduated from the technology track, and not the transfer track, Kerri aspires to earn a higher degree in engineering.

Mary. Mary earned a Bachelor of Arts degree from a four-year school directly after graduating from high school and has had a full-time job working in the biology and chemistry fields for many years. She reported that she enrolled in various courses, including engineering technology courses, at the community college as a part-time student while continuing to work full-time. Mary chose the technology track because she wanted more of a hands-on, practical education than the transfer track could provide her.

Lois. Lois reported that she is a waitress and has been waitressing for many years. She has raised three children, one of whom recently earned her Bachelor of Science degree in civil engineering from a four year college. Lois enrolled in the engineering technology program at the community college as a full-time student, after many years of not being in school, but as a student she continued to waitress part-time. Similar to Mary, she wanted a hands-on practical education, so she chose the technology track because she considered the transfer track too theoretically based. Table 4.1 summarizes the participants’ relevant characteristics.

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Major</th>
<th>Concentration</th>
<th>Year Started</th>
<th>Year Graduated</th>
<th>Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathy</td>
<td>Engineering Transfer</td>
<td>Mechanical</td>
<td>2008</td>
<td>2010</td>
<td>Full-time</td>
</tr>
<tr>
<td>Kerri</td>
<td>Engineering Technology</td>
<td>Civil</td>
<td>2011</td>
<td>2013</td>
<td>Full-time</td>
</tr>
<tr>
<td>Mary</td>
<td>Engineering Technology</td>
<td>Architectural</td>
<td>2006</td>
<td>2009</td>
<td>Part-time</td>
</tr>
<tr>
<td>Lois</td>
<td>Engineering Technology</td>
<td>Civil</td>
<td>2011</td>
<td>2013</td>
<td>Full-time</td>
</tr>
</tbody>
</table>

Table 4.1 Participants’ relevant characteristics.
Research Design

This research was designed as a qualitative case study; more specifically as a single, holistic, case study. A qualitative study, as opposed to a quantitative study, was undertaken because qualitative studies are especially well suited for research such as this, that aimed to understand the particular contexts within which the research participants chose to enroll in engineering, and the influence these contexts had on the participants’ actions (Creswell, 2009; Maxwell, 2005). A case study format was used in accordance with Yin’s (2003) recommendation to employ a case study strategy “…when “how” or “why” questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context” (p. 1). The two central research questions that guided this research were both “how” questions and the researcher had no control over the participants’ choices to enroll in engineering, so a case study strategy met Yin’s (2003) criteria and seemed appropriate.

A single case study strategy, as opposed to a multiple case study strategy, was specifically chosen in accordance with one of the five rationales that Yin (2003) provides in which single case studies are appropriate. Yin describes research projects, in which the objective is to capture the circumstances of a representative school, as types of projects that lend themselves very well to a single case study strategy. The engineering program at the research site in this research is representative and typical of other two-year engineering programs at other colleges, and fits Yin’s criteria. The lessons learned from this research have been very informative about the typical female community college engineering student.

A holistic case study, as opposed to an embedded case study, according to Yin (2003) is advantageous when the case study seeks to examine “…the global nature…” of the unit of
analysis (p. 43). This research lent itself well to analyzing the participants as a single holistic unit, because it sought to examine common themes among women who chose engineering.

The four female graduates who responded to the invitation to participate formed the single, holistic, unit of analysis. Their perceptions of their academic choice, particularly the factors and contexts that they considered as having motivated them to choose engineering as a college major, were investigated.

**Data Collection**

The research methodology incorporated a written questionnaire, individual interviews and a focus group meeting as the three instruments used to collect data. The individual interviews were considered the primary data source because of the amount and depth of data that these provided. Three data sources were used to enhance the trustworthiness, particularly the credibility, of this research. Lincoln & Guba (1985) and Miles & Huberman (1994) posit that the trustworthiness of qualitative research involves establishing credibility, transferability, dependability and confirmability. Credibility and dependability are discussed in this chapter. Transferability and confirmability are discussed in chapter five, specifically in the section entitled Limitations of this Study.

A study’s credibility, in other words confidence in the truth of its findings, is threatened when the researcher makes inferences concerning the data that has been collected. Lincoln & Guba (1985), Miles & Huberman (1994) and Yin (2003), suggest triangulation as a technique that can be used to establish a qualitative study’s credibility. A major strength of a case study strategy is the opportunity to use many different sources of evidence because there is an opportunity to triangulate the data (Yin, 2003). In this research, triangulation occurred when the three data sources were used to corroborate facts and help yield converging conclusions.
A qualitative study’s dependability is analogous to a quantitative study’s reliability. Regardless of the term, these both refer to whether another researcher would arrive at the same conclusions as this researcher, if that later researcher repeated this case study exactly. Miles & Huberman (1994) describe this as “quality control” (p. 278) and suggest it is threatened when procedures are not documented. Developing a database and documenting all data were tactics that were incorporated in this study, as Yin (2003) advises.

Figure 4.2 is a graphic representation of the data collection process incorporated in this research.

![Figure 4.2 Data collection process](image)

**Patterns Suggested by Theory**

Yin (2009) discusses five specific techniques for analyzing case study data and the one that he describes as “the most desirable” (p. 136) is pattern matching logic. Such logic compares empirically emerging patterns with anticipated patterns. Through their expectancy-value theory, Eccles and her colleagues posit that the subjective values that individuals attach to choices, such as choices among college majors, can play a key role in leading those individuals toward making a particular choice (Eccles et al., 1993). Eccles suggests that women with high academic confidence and expectations for success in engineering may not choose engineering as a college
major, if they do not place a high level of personal value on earning an engineering degree.

Figure 4.3 shows anticipated patterns of academic choice based on Eccles’ theory. The patterns that emerged from this research, and how these compare to the anticipated patterns based on theory, are discussed and graphically presented later.

![Figure 4.3 Graphical representation of anticipated patterns of academic choice based on expectancy-value theory.](image)

**Data Analysis**

A consistent approach to analysis was sequentially performed on the questionnaire, interview transcripts and focus group transcript. Specifically the researcher employed a two cycle coding process shown in Figure 4.4.
In the first cycle, Saldaña’s (2009) affective methods/values coding methodology was used in two phases. Phase I consisted of searching for a priori and in vivo codes in the data source. Phase II consisted of categorizing the coded passages as either a “belief” or “value”, as prescribed by Saldaña (2009), by analyzing how the coded passages were nested in their contexts and arriving at their meaning. In the second cycle, Saldaña (2009) pattern coding was used to further categorize the beliefs and values into the five constructs of Eccles’ (1983) expectancy-value theory. Frequency analysis and qualitative interpretation of the second cycle coded passages identified emerging themes which informed subsequent steps in the data analysis.

*Figure 4.4. Overview of the first and second cycle coding process applied to each data source (questionnaires, interview transcripts and focus group transcripts). Emerging themes from each coded and analyzed data source informed the next step of the analysis process.*
process. Implementation and the outcomes of this methodology are elaborated on in the discussion below.

**Questionnaire**

The rationale for choosing to use a questionnaire as a data source was that it allowed the participants to provide written, thoughtful responses to questions, in a personal and private setting of their choice, with no immediate time constraints. The questionnaire was created by the researcher and distributed through email to all four participants. It consisted of ten open-ended, non-leading questions. The questions were open ended, to encourage the participants to provide full, meaningful answers based on their own knowledge and/or feelings, and non-leading, to avoid responses that were false or slanted. Participants were asked to complete and return the questionnaires through email. All four participants returned their completed questionnaires within three weeks of receiving these.

Framed in expectancy-value theory, in particular Eccles (Parsons) et al. (1983) Expectancy Value Theory of Achievement Related Task Choices, the main purpose of all the questions was to assess the participants’ perceptions of why they chose engineering as a major. The ten questions posed to each participant are shown in Table 4.2. This table also shows the relationship between these questions and the two central research questions, as well as how the questions are grounded in the theoretical framework. The questionnaire is included in Appendix B and the participants’ responses are included in Appendix C.
<table>
<thead>
<tr>
<th>Central Research Questions</th>
<th>Theoretical Framework Construct</th>
<th>Questionnaire Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering?</td>
<td>Expectations for Success/Personal Efficacies Construct</td>
<td>Please describe when and how you first became interested in engineering. Perhaps many things influenced you to enroll in engineering. If you had to list just one reason why you chose engineering, what would it be? How would you describe your academic skills, particularly in math and science, as compared to other people that you know? Do you think that your math and science skills largely contributed to your decision to choose engineering, or are there other things that had more influence on your decision? If you had to describe yourself, which are you more likely to say: that you are good at engineering or that you enjoy engineering, or neither, and why?</td>
</tr>
<tr>
<td>How do women perceive their subjective task values as influencing their decisions to enroll in engineering?</td>
<td>All Values Constructs</td>
<td>Please describe when and how you first became interested in engineering. Perhaps many things influenced you to enroll in engineering. If you had to list just one reason why you chose engineering, what would it be? If you had to describe yourself, which are you more likely to say: that you are good at engineering or that you enjoy engineering, or neither, and why?</td>
</tr>
<tr>
<td>Interest-Enjoyment Value Construct</td>
<td></td>
<td>Are you currently working in the field of engineering? If so, please describe what you do. Do you think engineering is a good fit for you, and why or why not?</td>
</tr>
<tr>
<td>Attainment Value Construct</td>
<td></td>
<td>Suppose you were a high school guidance counselor. How would you describe the field of engineering to your advisees? Do you think more women should consider engineering as major, and if so, why?</td>
</tr>
<tr>
<td>Utility Value Construct</td>
<td></td>
<td>Suppose you were a high school guidance counselor. How would you describe the field of engineering to your advisees? Do you think more women should consider engineering as major, and if so, why?</td>
</tr>
<tr>
<td>Relative Cost Construct</td>
<td></td>
<td>Suppose you were a high school guidance counselor. How would you describe the field of engineering to your advisees? Do you think more women should consider engineering as major, and if so, why?</td>
</tr>
</tbody>
</table>

Final Question: Please list any additional comments you might have about why you chose engineering.

*Table 4.2* Questionnaire questions and their relationship to the central research questions and the theoretical framework.
The questionnaire responses were coded by the researcher in two cycles, as shown in Figure 4.4, as a means to identify emerging themes surrounding the participants’ choices to enroll in engineering. The coding process is described below.

**First Cycle Coding.** Saldaña (2009) provides seven methods of first cycle coding, and one of the seven is “Affective Methods” (p.46). He explains that Affective Methods first cycle coding should be used to investigate human experiences. Under the Affective Methods category of coding, Saldaña (2009) provides four subcategories, and the one that was incorporated in this case study is “Values Coding” (p. 46).

Saldaña (2009) defines Affective Methods/Values Coding as the “. . . application of codes onto qualitative data that reflect a participant’s values, attitudes, and beliefs, representing his or her perspectives . . .” (p. 89). Therefore, Affective Methods/Values Coding was considered particularly appropriate for this case study because the researcher aimed to discover the human experiences behind the participants choices of engineering, and Saldaña’s (2009) definition harmonized considerably well with the expectancy-value theoretical framework’s constructs of beliefs and values. First cycle coding, specifically Affective Methods/Values Coding, was performed in two phases, as Saldaña (2009) recommends.

**Phase I.** Phase I consisted of generating a preliminary list of codes and applying these codes to the questionnaire responses. The codes were derived by the researcher after reflecting on both the applied definitions of each of the constructs in Eccles’ (1983) theoretical framework and the central research questions. Saldaña (2009) discusses how such “a provisional list of codes should be determined beforehand to harmonize with your study’s conceptual framework or paradigm, and to enable an analysis that directly answers your research questions and goals” (p. 49). Miles and Huberman (1994) similarly recommend that “one method of creating codes - the
one we prefer - is that of creating a provisional ‘start list’ of codes prior to fieldwork” (p. 58).

The researcher-generated start list of codes and the relationships among this start list, the central research questions and the theoretical framework are shown in Table 4.3.
<table>
<thead>
<tr>
<th>Central Research Questions</th>
<th>Constructs of Theoretical Framework</th>
<th>Theoretical Definition (Eccles, 1983)</th>
<th>Applied Definition</th>
<th>First Cycle Start List Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering?</td>
<td>Academic Efficacies &amp; Expectations for Success</td>
<td>A person's beliefs associated with current competencies and how well he or she will perform on an upcoming task</td>
<td>Choosing engineering because of strengths in math &amp; science</td>
<td>Believe, Choose, Decide, Difficult, Easy, Enroll, Excel, Good, Hard, Math, Science, Select, Strong, Struggle, Take, Think</td>
</tr>
<tr>
<td>How do women perceive their subjective task values as influencing their decisions to enroll in engineering?</td>
<td>Interest-Enjoyment</td>
<td>The immediate rewards, intrinsic or extrinsic, an individual derives from performing the task</td>
<td>Choosing engineering based on interest and enjoyment</td>
<td>Choose, Decide, Enjoy, Enroll, Fun, Good, Interest, Intrigue, Like, Love, Select, Take</td>
</tr>
<tr>
<td></td>
<td>Attainment</td>
<td>A person's self-image of whom he or she is and whom he or she would like to be</td>
<td>Choosing engineering because it is perceived as a good fit</td>
<td>Choose, Decide, Enroll, Fit, Good, Important, Myself, See, Select, Take</td>
</tr>
<tr>
<td></td>
<td>Utility</td>
<td>Whether and to what extent undertaking a particular task will assist one in reaching some desired end state</td>
<td>Choosing engineering because an engineering degree will be useful in the future</td>
<td>Choose, Decide, Enroll, Important, Need, Select, Take, Use</td>
</tr>
<tr>
<td></td>
<td>Relative Cost</td>
<td>Whether and to what extent undertaking a particular task will limit time and energy that could be spent on other activities</td>
<td>Choosing engineering despite the amount of effort required and its impacts on other activities</td>
<td>Choose, Cost, Decide, Difficult, Easy, Enroll, Hard, Sacrifice, Select, Struggle, Take, Time</td>
</tr>
</tbody>
</table>

*Table 4.3* Relationship among first cycle start list codes, research questions and the theoretical framework’s constructs.
During phase I, the researcher searched for the appearance of the first cycle start list codes in the questionnaire responses and manually highlighted these in yellow. As the researcher highlighted the codes in the questionnaire responses, additional words and phrases emerged from the participants’ responses that the researcher had not included in the start list of codes. Saldaña (2009) recommends putting these inductive “in vivo” codes in quotation marks in the margins of the questionnaires (p. 75). The process of generating a start list of codes, highlighting them, and including in vivo codes in quotation marks comprised phase I of the Affective Methods/Values first cycle coding of the questionnaire responses. Table 4.4 demonstrates first cycle coding phase I by providing excerpts from the questionnaire data. In this table, the start list codes are highlighted and the in vivo codes are in quotation marks. Q indicates that the questionnaire is the data source. The entire first cycle start list and in vivo codes are shown in Appendix F.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Data Source</th>
<th>Excerpt with First Cycle Phase I Code Words Highlighted</th>
<th>First Cycle Start List Code Examples</th>
<th>First Cycle In Vivo Code Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathy</td>
<td>Q</td>
<td>I have always <strong>excellent</strong> . . .</td>
<td>Exelled</td>
<td></td>
</tr>
<tr>
<td>Lois</td>
<td>Q</td>
<td>Those skills were definitely a contributing factor . . .</td>
<td></td>
<td>“factor”</td>
</tr>
<tr>
<td>Mary</td>
<td>Q</td>
<td>Engineering was <strong>intriguing</strong> to me...</td>
<td>Intriguing</td>
<td></td>
</tr>
<tr>
<td>Cathy</td>
<td>Q</td>
<td>My <strong>math</strong> skills did play a small role . .</td>
<td>Math</td>
<td>“role”</td>
</tr>
<tr>
<td>Lois</td>
<td>Q</td>
<td>I am remarkably <strong>strong</strong> . . .</td>
<td>Strong</td>
<td></td>
</tr>
<tr>
<td>Kerri</td>
<td>Q</td>
<td>I have only one view of engineering . .</td>
<td></td>
<td>“view”</td>
</tr>
</tbody>
</table>

*Table 4.4 Phase I of first cycle coding of questionnaire responses.*

**Phase II.** Phase II of first cycle coding of the questionnaire responses organized the phase I coded passages into two categories, specifically beliefs and values, as Saldaña (2009) instructs. This task was completed manually by the researcher and consisted of examining how the phase I
coded data functioned or was nested in its contexts. Saldaña (2009) defines beliefs as the individual’s personal knowledge and interpretive perceptions of her social world, and values as the importance an individual attributes to herself, another person, a thing, or an idea. These definitions harmonize quite well with Eccles’ (1983) theoretical definitions. Saldaña (2009) endorses using code letters B for belief and V for value; therefore, the researcher coded the data in that manner. These codes were written down on the questionnaires next to the phase I coded passages. Table 4.5 provides examples of phase I coded data and the category under which these were placed in phase II. In Table 4.5, Q indicates the questionnaire is the data source.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Data Source</th>
<th>Phase I Start List and In Vivo Codes</th>
<th>Phase II Belief (B) or Value (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerri</td>
<td>Q</td>
<td>(math and science) do not come easily to me.</td>
<td>B</td>
</tr>
<tr>
<td>Mary</td>
<td>Q</td>
<td>Engineering was intriguing to me...</td>
<td>V</td>
</tr>
<tr>
<td>Cathy</td>
<td>Q</td>
<td>My love of drawing . . .</td>
<td>V</td>
</tr>
<tr>
<td>Lois</td>
<td>Q</td>
<td>I am remarkably strong . . .</td>
<td>B</td>
</tr>
</tbody>
</table>

Table 4.5 Phase II of first cycle coding of questionnaire responses.

After phase II of first cycle coding was completed, second cycle coding was applied to the questionnaire data, as recommended by Saldaña (2009). Second cycle coding is described below.

**Second Cycle Coding.** Pattern coding was the second cycle coding method applied. Saldaña (2009) discusses five other second cycle coding methods, but he advises that these are best used for developing grounded theory or to build upon a previous study’s codes, and therefore these were not considered appropriate for this research. Pattern coding of the questionnaire responses, which were already coded into beliefs and values by first cycle coding,
was completed manually by the researcher and resulted in the data being further sorted into more specific themes.

Framed by Eccles (Parsons) et al. (1983) expectancy-value theory, five second cycle thematic codes were used, specifically personal efficacies/expectation for success (PE/EFS), interest-enjoyment value (IEV), attainment value (AV), utility value (UV) and relative cost (RC). Table 4.6 provides examples of second cycle coding of the questionnaire data into each of these five themes.
<table>
<thead>
<tr>
<th>Theoretical Framework’s Construct</th>
<th>Theoretical Definition (Eccles, 1983)</th>
<th>Applied Definition</th>
<th>First Cycle Phase I and II Coding</th>
<th>Second Cycle Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Efficacies &amp; Expectations for Success</td>
<td>A person's beliefs associated with current competencies and how well he or she will perform on an upcoming task</td>
<td>Choosing engineering because of strengths in math &amp; science</td>
<td>Lois: I am remarkably strong in both disciplines. <strong>Belief (B)</strong></td>
<td>PE/EFS</td>
</tr>
<tr>
<td>Interest-Enjoyment Value</td>
<td>The immediate rewards, intrinsic or extrinsic, an individual derives from performing the task</td>
<td>Choosing engineering based on interest and enjoyment</td>
<td>Mary: Engineering was <strong>intriguing</strong> to me. <strong>Value (V)</strong></td>
<td>IEV</td>
</tr>
<tr>
<td>Attainment Value</td>
<td>A person's self-image of whom he or she is and whom he or she would like to be</td>
<td>Choosing engineering because it is perceived as a good fit</td>
<td>Cathy: I do think that it is a <strong>good fit</strong>. <strong>Value (V)</strong></td>
<td>AV</td>
</tr>
<tr>
<td>Utility Value</td>
<td>Whether and to what extent undertaking a particular task will assist one in reaching some desired end state</td>
<td>Choosing engineering because an engineering degree will be useful in the future</td>
<td>Kerri: Every time I began a project I <strong>needed</strong> a civil engineer . . . <strong>Value (V)</strong></td>
<td>UV</td>
</tr>
<tr>
<td>Relative Cost</td>
<td>Whether and to what extent undertaking a particular task will limit time and energy that could be spent on other activities</td>
<td>Choosing engineering despite the amount of effort required and its impacts on other activities</td>
<td>Cathy: I would describe it as <strong>hard</strong> work, but rewarding work. <strong>Value (V)</strong></td>
<td>RC</td>
</tr>
</tbody>
</table>

*Table 4.6 Second cycle coding of questionnaire responses.*

The researcher then tabulated the number of times the second cycle coded passages were found in the questionnaire responses from each participant. The results of this analysis are shown in Figure 4.5
Emerging Themes. Themes that emerged from first and second cycle coding and subsequent analysis of the questionnaire responses were:

- **Personal Efficacies/Expectations for Success:** Mary and Lois seemed to have had relatively strong personal efficacies and expectations for success in engineering, as compared to Cathy who had somewhat less and Kerri who had none.
- **Interest-Enjoyment Value:** Cathy, Mary and Lois seemed to have had a greater interest-enjoyment value associated with engineering-related activities at the time when they enrolled, as compared to Kerri.
- **Attainment Value:** Cathy and Lois seemed to have relatively high attainment value associated with their choice to enroll in engineering, as compared to Kerri who had somewhat less and Mary who had none.
- **Utility Value:** All four participants associated some utility value with earning an engineering degree; Kerri and Mary more so than Cathy and Lois.
Relative Cost: All four participants seemed to have associated similar relative costs with earning an engineering degree.

The researcher reflected on these emerging themes, which helped inform the subsequent face-to-face interviews, which were the second instrument used to collect data. The themes provided a platform, together with the interview outline, from which the researcher could delve into deeper conversations with each participant.

**Interviews**

The rationale for using individual interviews as a data source was that the interviews facilitated direct access to the participants, providing opportunities for the participants to further elaborate on their choice of engineering and allowing the researcher to probe the participants on emerging themes. Face-to-face individual interviews were also beneficial because the researcher anticipated that the written and verbal communication skills of each participant might vary; therefore, collecting written responses from the questionnaire and verbal responses from the interviews was expected to result in richer data. Each participant had signed the consent form (included in Appendix A) allowing the interviews to be audio-recorded. Each interview lasted approximately one hour.

A semi-structured interview protocol was utilized by the researcher. The interview outline with discussion points is included in Appendix D, and was grounded in the central research questions and theoretical framework. The relationship between the research questions, the interview discussion points and the theoretical framework is shown in Table 4.7.
<table>
<thead>
<tr>
<th>Central Research Questions</th>
<th>Interview Discussion Point</th>
<th>Theoretical Framework's Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering?</td>
<td>Please elaborate on when and how you first became interested in engineering.</td>
<td>✓</td>
</tr>
<tr>
<td>How do women perceive their subjective task values as influencing their decisions to enroll in engineering?</td>
<td>Before you enrolled in engineering, did you consider enrolling in other programs such as nursing or health sciences? If so, what attracted you to those programs and why did you ultimately choose engineering? What do you like most about engineering so far? The least? Has engineering turned out to be what you thought it would be? Would you like to see more women in engineering? Why do you think so few women choose engineering as compared to men? What would you tell other women about engineering now that you are an engineering student? Do you think that it is important for engineering students to have really good math skills to be successful? Do you think that the engineering field does a good job at promoting the profession? What could colleges do to attract more women to engineering?</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 4.7 Relationship among central research questions, theoretical framework’s constructs and interview discussion points.
Each interview began with the researcher describing the interview protocol and asking each participant to elaborate on when and how they first became interested in engineering. The participants’ responses were lengthy and triggered a number of probing questions. The researcher used the interview as a means to confirm or reject the themes that had emerged from the questionnaire responses and to allow new themes to emerge. Questions #3, #4 and #7 on the interview outline were not posed because those topics were designed to be discussed with currently enrolled students. The IRB would not allow currently enrolled students to participate in this research, only graduates, so these questions were no longer pertinent. Elimination of these questions had no adverse effect on the research since the remaining questions were also grounded in Eccles’ (1983) theoretical framework as shown in Table 4.7. Sample responses to the interview questions are provided in Table 4.8.
<table>
<thead>
<tr>
<th>Interview Questions</th>
<th>Sample Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please elaborate on how and when you first became interested in engineering.</td>
<td><strong>Cathy:</strong> It was like this [computer-aided drafting] seems cool. High school is where everything kind of clicked for me.</td>
</tr>
<tr>
<td></td>
<td><strong>Kerri:</strong> I did [real estate] sales and had my own projects rolling on the side and I needed a structural engineer to come in and say ‘oh, that's ok’.</td>
</tr>
<tr>
<td></td>
<td><strong>Lois:</strong> I never thought about going into engineering until I saw the subject matter she [her daughter] was dealing with. It was something that interested me.</td>
</tr>
<tr>
<td></td>
<td><strong>Mary:</strong> First I just took Introduction to Computers. I liked it, so I decided to sign up for more classes.</td>
</tr>
<tr>
<td>Before you enrolled in engineering, did you consider enrolling in other programs such as nursing or health sciences? If so, what attracted you to those programs and why did you ultimately choose engineering?</td>
<td><strong>Cathy:</strong> Both my parents were in the medical field. I knew I never really wanted to be in medicine. I always liked art. So [computer aided drafting] seemed kind of cool.</td>
</tr>
<tr>
<td></td>
<td><strong>Kerri:</strong> I came here [the community college] first for medical technology and I said this isn’t for me. I did real estate sales for four years. It was definitely the construction thing and real estate. That’s when I chose [engineering].</td>
</tr>
<tr>
<td>Would you like to see more women in engineering?</td>
<td><strong>Lois:</strong> I think they need women because our outlook is probably a little bit different.</td>
</tr>
<tr>
<td>Why do you think so few women choose engineering as compared to men?</td>
<td><strong>Kerri:</strong> They don’t know [what an engineer is or does].</td>
</tr>
<tr>
<td></td>
<td><strong>Lois:</strong> There are so many directions you can go into, but you don’t realize that. And you can be creative once you get there.</td>
</tr>
<tr>
<td>Do you think that it is important for engineering students to have really good math skills to be successful?</td>
<td><strong>Kerri:</strong> More than the math and science skills . . . creativity is more important.</td>
</tr>
<tr>
<td></td>
<td><strong>Cathy:</strong> Are you interested in this? Do you like to work in teams? Do you communicate well? These are the things that I’d say are important.</td>
</tr>
<tr>
<td>Do you think that the engineering field does a good job at promoting the profession?</td>
<td><strong>Lois:</strong> No, I knew nothing about it.</td>
</tr>
<tr>
<td></td>
<td><strong>Cathy:</strong> It’s not all about the computer, it’s about working with a team, communicating, designing, making.</td>
</tr>
<tr>
<td>What could colleges do to attract more women to engineering?</td>
<td><strong>Cathy:</strong> You can say you are creative? Do you have good communication skills?</td>
</tr>
<tr>
<td></td>
<td><strong>Mary:</strong> I would say that it’s exciting and has a lot of variety. There are a lot of different things you can try.</td>
</tr>
</tbody>
</table>

*Table 4.8. Sample responses to interview questions.*
The semi-structured protocol provided the participants the freedom to diverge from a rigid set of questions, allowing the opportunity to confirm previously emerging themes and for potential new themes to emerge. Having already completed the questionnaire, participants were acquainted with the research goals and were prepared for in-depth discussions.

These individual semi-structured interviews were considered the primary data source because of the amount and depth of data that these provided. The interview conversations provided context-rich and meaningful (“thick”) descriptions which, according to Miles & Huberman (1994), can enhance the credibility of research. The interviews were all audio-recorded and later transcribed verbatim by the researcher. The transcriptions allowed repeated access to the data, making unnecessary any sole reliance on notes jotted down by the researcher.

The interview transcripts were analyzed in the same manner that the questionnaire responses were analyzed; i.e., they were subjected to two cycles of coding. The coding process and emerging themes are described next.

First Cycle Coding. Just as the questionnaire responses were coded, first cycle coding of the interview transcripts was applied in two phases, using Saldaña’s (2009) Affective Methods/Values coding.

Phase I. The same first cycle phase I codes that were used to code the questionnaire responses were applied to the interview transcripts. The code list included the original researcher-generated start list plus any in vivo codes that had emerged from the analysis of the questionnaire responses. The researcher utilized the Advanced Find feature in Microsoft Word 2010 to highlight the codes in the transcripts. This was subsequently checked manually by the researcher. As the transcripts were read, additional in vivo codes were identified.
**Phase II.** In a manner identical to how the questionnaire responses were coded, phase II of first cycle coding of the interview transcripts refined the phase I coded passages into categories of beliefs (B) and values (V). This was completed manually by the researcher.

Examples of phase I and phase II first cycle coding are shown in Table 4.9. In the table, the letter I indicates the data source was the interviews.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Data Source</th>
<th>Phase I Start List Codes</th>
<th>Phase II Belief (B) or Value (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary</td>
<td>I</td>
<td>“It (math) wasn’t as hard for me...“</td>
<td>B</td>
</tr>
<tr>
<td>Lois</td>
<td>I</td>
<td>“... it was something that interested me.”</td>
<td>V</td>
</tr>
<tr>
<td>Cathy</td>
<td>I</td>
<td>“I always liked art...“</td>
<td>V</td>
</tr>
<tr>
<td>Kerri</td>
<td>I</td>
<td>“... I need that degree.”</td>
<td>V</td>
</tr>
</tbody>
</table>

*Table 4.9 Phase I and II of first cycle coding of interview transcripts.*

**Second Cycle Coding.** The same second cycle coding method (pattern coding) and code list (PE/EFS, IEV, AV, UV and RC) that were applied to the questionnaire responses were also applied to the interview transcripts. Second cycle coding of the interview transcripts was completed manually by the researcher and resulted in the data being grouped together under these five specific themes. Table 4.10 provides examples of second cycle coding of the interview transcripts.
<table>
<thead>
<tr>
<th>Theoretical Framework’s Construct</th>
<th>Theoretical Definition (Eccles, 1983)</th>
<th>Applied Definition</th>
<th>First Cycle Phase I and II Coding</th>
<th>Second Cycle Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Efficacies &amp; Expectations for Success</td>
<td>A person's beliefs associated with current competencies and how well he or she will perform on an upcoming task</td>
<td>Choosing engineering because of strengths in math &amp; science</td>
<td>Mary: It (math) wasn’t as hard for me... Belief (B)</td>
<td>PE/EFS</td>
</tr>
<tr>
<td>Interest-Enjoyment Value</td>
<td>The immediate rewards, intrinsic or extrinsic, an individual derives from performing the task</td>
<td>Choosing engineering based on interest and enjoyment</td>
<td>Lois: It was something that interested me... Value (V)</td>
<td>IEV</td>
</tr>
<tr>
<td>Attainment Value</td>
<td>A person's self-image of whom he or she is and whom he or she would like to be</td>
<td>Choosing engineering because it is perceived as a good fit</td>
<td>Lois: I can see myself working in that field. Value (V)</td>
<td>AV</td>
</tr>
<tr>
<td>Utility Value</td>
<td>Whether and to what extent undertaking a particular task will assist one in reaching some desired end state</td>
<td>Choosing engineering because an engineering degree will be useful in the future</td>
<td>Kerri: I need that degree. Value (V)</td>
<td>UV</td>
</tr>
<tr>
<td>Relative Cost</td>
<td>Whether and to what extent undertaking a particular task will limit time and energy that could be spent on other activities</td>
<td>Choosing engineering despite the amount of effort required and its impacts on other activities</td>
<td>Mary: “...what it would take to get a degree.” Value (V)</td>
<td>RC</td>
</tr>
</tbody>
</table>

Table 4.10  Second cycle coding of interview transcripts.

Figure 4.6 presents the number of times second cycle coded passages were found in the interview transcripts for each participant.
Figure 4.6 Frequency of second cycle codes identified in the interview transcripts, by participant.

*Emerging Themes.* The themes that emerged from the first and second cycle coding of the interview transcripts are listed below. These themes correlated well with the themes that had emerged from the questionnaire responses. A discussion on each emerging theme follows this list.

**Personal Efficacies/Expectations for Success:** Cathy, Mary and Lois again emerged as having had stronger personal efficacies and expectations for success in engineering, as compared to Kerri, who again emerged as having none.

**Interest-Enjoyment Value:** Cathy, Mary and Lois again emerged as having had higher interest-enjoyment values associated with engineering, as compared to Kerri, who this time emerged as having none.
Attainment Value: Cathy, Kerri and Lois again emerged as having associated higher attainment values with their choice of engineering, as compared to Mary, who again emerged as having none.

Utility Value: Kerri and Lois emerged as having associated higher utility values with earning an engineering degree, as compared to Cathy, who emerged as having associated relatively less, and to Mary, who seemed to have none.

Relative Cost: Kerri, Mary and Lois again emerged as having associated a relative cost with earning an engineering degree, but this time Cathy, seemed to have none.

Discussion of Emerging Themes. These five themes emerged from an analysis of the frequency of occurrences of the coded passages in the interview data. However, frequency of occurrence was not the only criteria used to identify the primary motivation behind each participant’s choice to enroll in engineering. The researcher also took into account that the frequency of the occurrence of the coded passages may have been higher in those participants who were more verbose than others during the interviews. In other words, the frequency tables do not reflect whether a participant spoke less but perhaps more emphatically and conclusively concerning her choice to enroll in engineering as compared to the other participants. Further analysis included consideration of the following:

Theme 1: Personal Efficacies/Expectations for Success. Cathy, Mary and Lois again emerged as having stronger personal efficacies and expectations for success in engineering, as compared to Kerri, who again emerged as having none. Mary said, “My academic skills in math and science are above average”, and Cathy’s and Lois’ responses were similar. These three participants also considered themselves as having strong spatial reasoning skills, which involve the ability to mentally rotate objects around axes in three dimensions.
Kerri, on the other hand, strongly indicated that she had little or no self-confidence in her math and science abilities by repeatedly mentioning that she had always struggled with these topics. When probed about her spatial reasoning abilities, she said, “I can tell you today, that I still have an issue with space . . . I have no concept of size.”

The above excerpts lend strong support to the first theme that emerged from first and second cycle coding of the questionnaires and the interviews, specifically that Cathy, Mary and Lois all have strong self-efficacies and expectations for success in engineering whereas Kerri had none. However, when Cathy, Mary and Lois discussed whether they perceived that their strong self-efficacies and expectations for success in engineering were the primary influences on their choices to enroll in engineering, all three clearly indicated during their interviews that this was not the primary reason why they chose engineering. The primary influences emerged as the interview conversations progressed.

While on this topic of self-efficacies in math and science, the researcher probed the participants regarding gendered stereotypes. The literature review had exposed that some other researchers, namely Hill et al. (2010), blame male stereotypes for low female enrollment in engineering. The participants expressed that they did not believe in gendered stereotypes, such as males are better at engineering than females. For example, Cathy said, “Basically we all have done the same education, so technically we can all do the same things.” Lois said, “I think it all goes by the individual, it has nothing to do with gender”.

**Theme 2: Interest-Enjoyment Value.** The three participants who emerged as having strong math and science skills and high expectations for success in the engineering program, namely Cathy, Mary and Lois, also directly stated that they had a very strong interest in engineering subject matter and that they thought they would really enjoy majoring in
engineering. Although the frequency of occurrences of the personal-efficacies/expectations for success (PE/EFS) code appeared stronger than the interest-enjoyment value (IEV) for Cathy and Lois, these two participants directly stated that their interest in and/or enjoyment of engineering related activities was the primary reason why they chose engineering, as did Mary, and not their self-efficacies.

Cathy indicated that her math and science abilities played a small role in her decision to choose engineering, but she said, “My love of drawing and my attention to detail really played a much bigger role.” She explained that prior to college she attended a vocational high school with the intent to study art because she “always liked art”. When she was at the vocational high school, she participated in 16 brief “shop” classes, after which she identified her top choice as computer aided drafting. She credits her drafting shop teacher for showing her that computer aided drafting can play a big role in some engineering disciplines, and that engineering has artistic sides to it, which she might like.

Lois explained that she chose engineering at a time when her youngest daughter, who was pursuing her degree in civil engineering at a nearby university, would work on her homework problems at home, in Lois’ presence. Lois became intrigued by the subject matter so she decided to try engineering herself. She said, “I liked that fact that there were some creative parts to it, like designing roadways.”

Mary also indicated that she had a strong interest in engineering, which primarily influenced her decision to enroll. While working full-time as a lab technician in a biology and chemistry lab, she initially enrolled in computer classes at the community college as a part-time student. When she eventually ran out of computer courses to take, she enrolled in a construction and land surveying course, which is a core engineering course in the architectural and civil
engineering technology and transfer programs at the community college. “Surveying seemed like it would be a lot of fun, so that’s how I got into engineering,” she said. She noted “I really made the decision based on interest.”

Kerri, on the other hand, who reported that she had always struggled with math, did not indicate that she thought she would enjoy engineering prior to enrolling at all. She did say, however, that she found some of the engineering courses interesting once she enrolled, but clearly indicated that interest and enjoyment were not factors in her decision to choose engineering. When asked to discuss any particular aspects of engineering that interested her enough to choose engineering, she replied, “No, it was all business for me, business and money.” As compared to the other three participants, she emerged as a unique case, in that her choice of engineering seems to have been made based largely on utility value, as further discussed below.

**Theme 3: Attainment Value.** Attainment value, as defined by Eccles’ (1983), is related to a person’s self-image of whom she is, or whom she would like to be. The presence of attainment value in the data would be indicative of whether or not the participants considered engineering to be a good match for them, possibly prompting them to enroll. Cathy, Kerri and Lois again emerged as associating higher attainment values with their choice of engineering, as compared to Mary, who again emerged as having none.

When Cathy was asked to consider her decision to choose engineering, she outright stated that she thought engineering was “a good fit” for her. She explained that it would enable her to use her “love of art to aid in designs and interpretation of other people’s designs.” These quotes demonstrate an attainment value, because Cathy clearly stated that she thought engineering would be a good fit for her, as well as an interest-enjoyment value, because she indicated that she loved to design things and she considered engineering as an opportunity to design.
Lois shared that when she talked to her daughter about engineering she was intrigued by the subject matter and realized that she could picture herself in that line of work. She went on to say that she thought engineering seemed to align with her interests and curiosity. Her statements suggest that she associated some attainment value, as well as a high interest in and enjoyment of engineering related activities, with her choice of engineering.

Analysis of Kerri’s interview responses revealed that attainment value also played a role in her decision to choose engineering. Kerri worked in real estate sales and in that capacity she often came in contact with engineers who were hired to survey property boundaries or to inspect the structural integrity of buildings and homes. Kerri could see herself doing those lines of work. Although she demonstrated low self-efficacies and expectations for such in engineering, she did say that she considered engineering to be a good fit for her because she described herself as “creative and visionary” and she believes these attributes are important in engineering.

Mary revealed that, although she chose to enroll in engineering, she never had any intention of quitting her job as a natural sciences lab technician to pursue a career in engineering. Mary said of her decision to enroll, “I’m more to say that I enjoy engineering, because I don’t specifically use it [engineering principles] in my work. I took the classes for fun and out of curiosity.” This quote supports the emerging theme that the interest-enjoyment value that she associated with engineering played a much larger role in her decision to choose engineering than did any attainment value that she associated with engineering.

**Theme 4: Utility Value.** Utility value, as defined by Eccles (1983) is related to how useful a person considers an engineering degree. Kerri and Lois emerged as having associated higher utility values with earning an engineering degree, as compared to Cathy, who emerged as having associated relatively less, and to Mary, who seemed to have none.
Kerri indicated that she chose engineering primarily because of her experiences with real estate and construction. She explained that once she was involved in a construction project that involved knocking down interior walls in an older building. “I needed a structural engineer to come in and say that it was ok”, she said. Kerri indicated that she was frustrated with having to hire an engineer to do tasks that she thought she could potentially perform herself if she earned an engineering degree. Kerri earned her engineering technology degree and has plans to earn her bachelor’s degree, gain experience, apply for a professional engineering license and return to real estate sales.

Through the lens of Eccles’ (Parsons et al. 1983) expectancy-value theory, Kerri’s comments demonstrate her attainment value, as well as the utility value that she assigns to obtaining her an engineering degree. Through Kerri’s eyes, having her bachelor’s degree in engineering will enable her to eventually reach her ultimate desired end state of being in real estate sales and not having to hire engineers to perform some of the associated work. Kerri wants to have the authority to approve the work herself. The utility value that Kerri assigned to earning her engineering technology degree appears to be so high, that it outweighed the fear that she said she had of enrolling in engineering.

The other three participants, namely Cathy, Mary and Lois, did not emphasize that their choice to enroll in engineering was based on a goal of reaching some ultimate desired end state, as did Kerri, and that is how utility value is defined in the theoretical framework. Analysis of Cathy’s responses revealed that her choice to pursue an engineering degree was not based on the utility value she assigned to engineering. The utility value she demonstrated appeared to have been an afterthought. For example, Cathy described how she hoped to use her degree, now that she has earned it, to “make a difference for women in high school and middle school by
participating in community outreach.” Cathy also indicated that now that she has her bachelor’s
degree in engineering, she plans to pursue her master’s degree in business administration
(M.B.A.). This can be interpreted as a utility value, because Cathy is indicating that she may use
her engineering degree as a springboard to obtaining her master’s degree in business
administration; however, Cathy’s statements do not demonstrate that the reason why she initially
chose engineering was based on what she could do with her engineering degree once she earned
it. This research has focused on choice, and Cathy’s choice to enroll appeared to have been more
heavily influenced by her interest-enjoyment and attainment values than the initial utility value
that she associated with engineering.

Lois described how she considered engineering as “a career that can offer some financial
security.” Although Lois’ choice to study engineering appears largely attributable to the interest-
enjoyment value she assigned to engineering, this statement suggests that her choice was also
moderately influenced by the utility value she placed on an engineering degree.

Mary indicated that she had no intention of utilizing her engineering degree to switch
careers. Mary appears to have chosen engineering based almost entirely on interest and
enjoyment.

Theme 5: Relative Cost. Kerri, Mary and Lois emerged as having associated a higher
relative cost with earning an engineering degree, in contrast to Cathy. Relative cost, as explained
by Wigfield & Eccles (2000), is how time spent on completing schoolwork can limit time spent
on other things. Since engineering is generally considered a rigorous discipline, some
researchers have pointed to this as a possible reason why there are so few women in engineering.
Some women may not choose engineering because they realize they may have to make sacrifices
in other areas of their lives and they may not consider earning an engineering degree worth the
time and effort that would be required (Wigfield & Eccles, 2000).

Relative cost is different than the other three subjective task value components, namely
interest-enjoyment, attainment and utility values, in how it can be applied. A high relative cost
associated with earning an engineering degree can be used as a reason why women may be
driven to choose college majors other than engineering. This researcher instead sought to
understand the role that relative cost plays in women’s choices to enroll in engineering. The
participants’ perceptions of the rigor surrounding engineering and what, if any, sacrifices they
thought they would have to make to earn their engineering degrees were examined.

Relative cost can also be thought of in terms of how it may affect persistence in
engineering. This research focused on choice, yet the persistence side of it is worth mentioning
and is discussed in chapter five. With regard to choice, most of the participants, namely Kerri,
Mary and Lois, reported that they knew engineering would be rigorous before they enrolled, but
that it did not drive them away from engineering toward other academic choices.

“Anybody can do it,” Kerri commented, “It’s how much time and effort you want to put
into learning the material. I chose it, I did it, because I needed that degree.” This suggests that
Kerri had such a strong utility value associated with obtaining her engineering degree that it
overrode the relative cost required of her to be successful. Kerri shared that she was “terrified”
of the amount of work that would lie ahead of her. Nevertheless, her perceptions of the relative
costs involved in enrolling in engineering evidently did not outweigh the utility value that she
associated with acquiring an engineering degree.

Mary and Lois thought engineering would be somewhat challenging, but evidently it did
not affect their decision to enroll. This may be associated with their competence beliefs; they
perceived themselves as having strong math and science skills and therefore they had confidence that they could be successful in engineering.

Cathy indicated that she did not anticipate engineering would be hard when she was considering enrolling and that she did not anticipate having to make many sacrifices to earn her degree. Although Cathy did admit that she found the engineering curricula to be “hard work” requiring her to have “a lot of sleepless nights”, this researcher has focused on the participants’ choices to enroll in engineering and not on their persistence once they enrolled.

Table 4.11 provides a summary of these five emerging themes. The researcher reflected on the themes that had emerged from the questionnaires and interviews, which helped inform the subsequent focus group meeting. Discussions with the participants during the focus group meeting enabled the researcher to corroborate these themes that had emerged. A discussion on the focus group follows Table 4.11.

<table>
<thead>
<tr>
<th>Emerging Themes</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrated Personal Efficacies/Expectations for Success in Engineering</td>
<td>Cathy, Mary and Lois</td>
</tr>
<tr>
<td>Demonstrated Interest in and Enjoyment of Engineering Related Activities</td>
<td>Cathy, Mary and Lois</td>
</tr>
<tr>
<td>Associated Attainment Value with their Choice of Engineering</td>
<td>Cathy, Lois and Kerri</td>
</tr>
<tr>
<td>Associated Utility Value with their Choice of Engineering</td>
<td>Cathy, Lois and Kerri</td>
</tr>
<tr>
<td>Considered the Relative Cost associated with Earning an Engineering Degree</td>
<td>Kerri, Mary and Lois</td>
</tr>
</tbody>
</table>

Table 4.11 Summary of Emerging Themes

**Focus Group**

The rationale for using a focus group discussion was to provide another opportunity for direct access to the participants. The focus group discussion points were developed to triangulate the data; i.e., to confirm the themes that had emerged from the questionnaire and interviews. Lincoln & Guba (1985) suggest employing such a member checking strategy, sometimes referred to as respondent validation (Maxwell, 2005), to enhance a study’s trustworthiness, particularly its credibility. Furthermore, knowing why some women chose engineering might be
helpful in encouraging other women to also enroll, and more informed recruitment strategies were the practical goals of this research.

Three of the four participants participated in the focus group meeting. All four participants were willing to participate; however, one participant was unable to due to a conflict with her work schedule that day. It would have introduced a hardship to the other participants if the focus group was rescheduled at the last minute, so the researcher decided to proceed with the focus group with three of the four participants.

The focus group discussions were audio-recorded, with the permission of all participants, and transcribed verbatim by the researcher. The focus group outline is included in Appendix E. Just as the questionnaire and the interviews were grounded in the central research questions and the theoretical framework, the focus group was as well, and the relationships are shown in Table 4.12.
<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Points</th>
<th>Personal Efficacies/ Expectations for Success</th>
<th>Interest - Enjoyment Value</th>
<th>Attainment Value</th>
<th>Utility Value</th>
<th>Relative Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering?</td>
<td>The researcher will open the discussion by asking the participants to share whether engineering turned out to be what they thought it would be like.</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td></td>
<td>The researcher will ask the participants to share with each other why they chose engineering.</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td></td>
<td>The researcher will identify the most common reason reported and open this up for discussion.</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td></td>
<td>The researcher will discuss reasons why women may be drawn to other fields and ask the participants to comment on this. For instance, women may be drawn to the health sciences because they see those fields as ones that primarily help other people. Perhaps they do not see engineering as a field that also helps people.</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>How do women perceive their subjective task values as influencing their decisions to enroll in engineering?</td>
<td>The researcher will ask the participants to share with each other why they chose engineering.</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td></td>
<td>The researcher will discuss reasons why women may be drawn to other fields and ask the participants to comment on this. For instance, women may be drawn to the health sciences because they see those fields as ones that primarily help other people. Perhaps they do not see engineering as a field that also helps people.</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td></td>
<td>The researcher will ask whether the participants think engineering needs a marketing overhaul.</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td></td>
<td>The researcher will ask the participants to share their ideas regarding how more women could be recruited into engineering.</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
</tbody>
</table>

*Table 4.12* Relationship among central research questions, focus group discussion points and theoretical framework.
The second discussion point listed in Table 4.11 was omitted from the focus group discussion because it was originally designed to be asked of currently enrolled students. The IRB would not allow currently enrolled students to be included in this research. In lieu of this question, the researcher asked why the participants chose the engineering technology track instead of the transfer track. The researcher asked this question because it was hoped that it might shed light on what particular aspects of the program the participants found appealing.

During the focus group meeting, the researcher asked the participants to share with each other why they chose engineering in general, in order to confirm the themes that had previously emerged. Kerri confirmed that she chose engineering based on the utility value an engineering degree would provide; i.e., she expected to avoid having to hire an engineer in future real estate transactions. Mary and Lois confirmed that they chose engineering based primarily on their interest in and enjoyment of engineering related activities.

Next, the researcher then discussed reasons why women may be drawn to other fields. The concept of how women may be drawn to the health sciences because they see those fields as ones that primarily help other people was introduced. All three participants indicated that women need to be more educated about the field of engineering and how engineers can provide benefits to people and society. This lead to a discussion on whether the participants thought that engineering needed a marketing overhaul and all three participants agreed that more information about the field of engineering should be made available, especially to high school students. The researcher then asked the participants to share their ideas regarding how more women could be recruited into engineering. The participants indicated that women should be provided with opportunities to hear a panel of female engineers speak about the profession. They believed that this would encourage more women to enroll.
The focus group transcripts were coded in the same manner as the questionnaire responses and interview transcripts. In particular, two phases of first cycle coding followed by second cycle coding were applied, as explained below.

**First Cycle Coding.** The same first cycle codes that were applied to the questionnaires and interviews were applied to the focus group transcript, in two phases, using Saldaña’s (2009) Affective Methods/Values coding.

*Phase I.* Phase I coding of the focus group transcript was completed by the researcher utilizing the Advanced Find feature in Microsoft Word 2010, and subsequently checked manually by the researcher.

*Phase II.* In a manner identical to how the questionnaire and interview transcripts were coded, phase II of first cycle coding of the focus group transcript refined the phase I coded passages into categories of beliefs (B) and values (V). Examples of phase I and phase II first cycle coding combined are shown in Table 4.13.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Data Source</th>
<th>Phase I Start List Codes</th>
<th>Phase II Belief (B) or Value (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lois FG</td>
<td>“I liked the fact that there are creative parts to it.”</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Kerri FG</td>
<td>“No (nothing intriguing about it). It’s all business for me, business and money”</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Mary FG</td>
<td>“I think that I would have figured out that engineering was a bad direction to take.”</td>
<td>B</td>
<td></td>
</tr>
</tbody>
</table>

*Table 4.13. Phase I and phase II of first cycle coding of focus group transcript.*

**Second Cycle Coding.** The same second cycle coding method (pattern coding) and code list (PE/EFS, IEV, AV, UV and RC) that were applied to the interview transcripts were also applied to the focus group transcript. A key for these codes is shown in Appendix F. Pattern coding of the focus group transcript was completed manually by the researcher and resulted in
the data being grouped together under specific themes. Table 4.14 provides examples of second cycle coding of the focus group transcript.

<table>
<thead>
<tr>
<th>Theoretical Framework’s Construct</th>
<th>Theoretical Definition (Eccles, 1983)</th>
<th>Applied Definition</th>
<th>First Cycle Phase I and II Coding</th>
<th>Second Cycle Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Efficacies &amp; Expectations for Success</td>
<td>A person's beliefs associated with current competencies and how well he or she will perform on an upcoming task</td>
<td>Choosing engineering because of strengths in math &amp; science</td>
<td>Lois: “Well, see, I have spatial skills” Belief (B)</td>
<td>PE/EFS</td>
</tr>
<tr>
<td>Interest-Enjoyment Value</td>
<td>The immediate rewards, intrinsic or extrinsic, an individual derives from performing the task</td>
<td>Choosing engineering based on interest and enjoyment</td>
<td>Lois: “I liked the fact that there were creative parts to it” Value (V)</td>
<td>IEV</td>
</tr>
<tr>
<td>Attainment Value</td>
<td>A person's self-image of whom he or she is and whom he or she would like to be</td>
<td>Choosing engineering because it is perceived as a good fit</td>
<td>Lois: “a lot of engineers I’ve met are men. . . as a woman, I could say ‘I think this is how it may work.’” Value (V)</td>
<td>AV</td>
</tr>
<tr>
<td>Utility Value</td>
<td>Whether and to what extent undertaking a particular task will assist one in reaching some desired end state</td>
<td>Choosing engineering because an engineering degree will be useful in the future</td>
<td>Kerri: “It was money. For me it was money.” Value (V)</td>
<td>UV</td>
</tr>
<tr>
<td>Relative Cost</td>
<td>Whether and to what extent undertaking a particular task will limit time and energy that could be spent on other activities</td>
<td>Choosing engineering despite the amount of effort required and its impacts on other activities</td>
<td>Mary: “I was anticipating that it would be challenging.” Value (V)</td>
<td>RC</td>
</tr>
</tbody>
</table>

*Table 4.14 Second cycle coding of the focus group transcript.*
The frequency of appearance of the second cycle coded passages in the focus group transcript is shown in Figure 4.7.

*Figure 4.7. Frequency of second cycle codes in the focus group transcript, by participant.*

**Emerging Themes.** Coding and analysis of the focus group transcript resulted in corroboration of the themes that had emerged from the interviews.

Personal Efficacies/Expectations for Success: Lois had relatively strong personal efficacies and expectations for success in engineering.

Interest-Enjoyment Value: Lois and Mary had relatively a lot of interest in, and enjoyment of, engineering related activities.

Attainment Value: Lois had associated some attainment value with her choice of engineering.
Utility Value: Kerri associated a relatively high utility value with her choice of engineering.

Relative Cost: Kerri considered the relative cost as high with her choice of engineering, as did Mary but to a lesser extent.

Discussion of Emerging Themes.

**Theme 1: Personal Efficacies/Expectations for Success.** Lois had relatively strong personal efficacies and expectations for success in engineering. This theme supports the themes that had emerged from the coding of the questionnaires and interview transcripts. During the focus group Lois again discussed how she believed she had excellent math and spatial reasoning skills, which she believed she was born with and always took for granted. Mary was not as verbose during the focus group as compared to Lois, but did indicate that even if she didn’t have strong academic skills, she would have chosen engineering anyway. Kerri said, “I was terrified right from the very beginning with that stupid math”, again suggesting that she had no personal efficacies or expectations for success in engineering.

**Theme 2: Interest-Enjoyment Value.** Lois and Mary had relatively a lot of interest in, and enjoyment of, engineering related activities. This theme supports the theme that had emerged from the coding of the questionnaires and interview transcripts. In all three data sets, Lois and Mary consistently described how they enjoyed engineering related activities. During the focus group, Lois again said that she enjoyed math related activities and was intrigued by engineering and Mary again described how she associated some engineering courses, particularly a land surveying course, with her love of the outdoors. Kerri emphatically answered “no” when probed about whether there was anything in particular about engineering that she found intriguing that might have influenced her choice to enroll.
Theme 3: Attainment Value. Lois associated some attainment value with her choice of engineering. This supports what had emerged from the coding of the questionnaires and interview transcripts, particularly with regard to Lois and Mary. Lois consistently emerged as having associated some attainment value with her choice and Mary consistently emerged as associating none.

Theme 4: Utility Value. Kerri associated a relatively high utility value with her choice of engineering. This supports what had emerged from the coding of the questionnaire and interview transcripts; in fact, Kerri emerged in all three data sources as associating utility value with her choice, and to a relatively larger degree than the other participants. During the focus group, when probed, Kerri again mentioned that a government program was paying for her degree. She clearly indicated that her decision to study engineering was based on practical and useful things such as “business and money”.

Theme 5: Relative Cost. Kerri considered the relative cost as high with her choice of engineering, as did Mary but to a lesser extent. This theme also supports themes that had emerged earlier and suggests that the participants did give consideration to the relative cost of earning an engineering degree when they were considering enrolling in the program. However, the relative cost that they associated evidently was not enough to sway them away from engineering.

Summary of Data Analysis

Figure 4.8 shows the combined frequency of occurrences of the codes from the questionnaires, interviews and focus group.
The above bar chart (Figure 4.8) suggests that Lois’ beliefs in her personal efficacies/expectations for success (PE/EFS) in engineering may have played the greatest role in influencing her to choose engineering, whereas values (IEV, AV, or UV) may have played the primary role in the other three participants’ choices of engineering. In particular, the bar chart suggests that the interest-enjoyment value (IEV) may have driven Cathy and Mary’s choices and utility value (UV) Kerri’s choice.

However, Lois directly stated in the questionnaire, interview and focus group that her personal efficacies/expectations for success in engineering, although important, were not the driving force behind her decision to enroll in engineering. Although the personal efficacies/expectations for success (PE/EFS) code appeared frequently in Lois’ data, Lois emphasized that she chose engineering primarily based on interest and enjoyment of engineering related activities as did Cathy and Mary.
Kerri emerged completely opposite to the other three participants in terms of academic self-efficacy/expectations for success and interest in/enjoyment of engineering related activities. Kerri showed little or no self-confidence in her math and science abilities by repeatedly mentioning that she had always struggled with these topics. She also did not express as much as the other participants did that she enjoyed engineering related activities or that she was interested in them when she decided to major in engineering.

Values in general seemed to have played an important role in all four of the participants’ decisions to choose engineering, and notably with Kerri, because she had practically no competence beliefs and low expectations for success in engineering courses, but associated such strong values with becoming an engineer that she decided to enroll anyway.

Cathy seems to have chosen engineering particularly out of enjoyment. She evidently has always loved drawing and art and considered engineering to be a field in which she could apply her artistic and creative talents. Similarly, Mary seems to have chosen engineering primarily based on interest and enjoyment. She evidently has a keen interest in the natural environment, enjoys the great outdoors and drew connections between aspects of civil engineering, particularly construction and land surveying, and the environment. Likewise, Lois strongly and repeatedly expressed how her intrigue with engineering related projects, such as bridge and road construction projects, mostly motivated her to enroll in engineering.

The patterns emerging from this research are shown graphically in Figure 4.9. This figure shows that values played a key role in the participants’ decisions to enroll in engineering. In particular, the interest-enjoyment value (shown outlined in bold and shaded in Figure 4.9) seems to have played the predominant role in the decision making pattern for Cathy, Mary and
Lois, and utility value (also shown outlined in bold and shaded in Figure 4.9) played the predominant role in the decision making pattern for Kerri.

Attainment value (shown in lesser bold outline and lighter shading in Figure 4.9) seems to have played a role in the decision making process, but to a lesser degree than the other values, based on the extent to which the participants emphasized interest-enjoyment and utility values. Cathy and Lois could clearly see themselves as engineers and Kerri similarly discussed how she connected her personal identity with that of an engineer, but the participants did not emphasize that this was the primary reason why they chose engineering.
Figure 4.9 Graphical representation of emerged patterns. Text boxes outlined in bold and shaded darkest represent the primary subjective task value associated with each participant’s choice to enroll in engineering.
**Research Findings**

The rich data collected from the participants, through written questionnaire responses, individual face-to-face interviews and a focus group meeting, and subsequently analyzed and cyclically coded in accordance with Saldaña (2009), during this qualitative, single case, holistic case study, resulted in the following findings:

Finding 1. Subjective task values played a salient role in all of the participants’ choices to enroll in engineering.

This finding supports the Expectancy-Value Model of Achievement Related Task Choices (Eccles et al., 1983); in particular, this finding demonstrates that the values that individuals attach to academic choices can play a key role in leading individuals toward making a particular choice.

Interest-enjoyment, attainment and utility values emerged as being present in all of the participants when they were considering enrolling in engineering. Analysis of the data from this research exposed that all four participants associated their choice of engineering particularly with the interest-enjoyment or utility value that they placed on earning an engineering degree.

Finding 2. Of the four subjective task value subcategories, the interest-enjoyment subjective task value played the primary role in the majority of the research participants’ choices to major in engineering.

This finding in general supports Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices; in particular, that values can play a key role.

Three of the four participants, namely Cathy, Mary and Lois, indicated that their interests in engineering subject matter and/or their enjoyment of engineering related activities were the primary reasons why they chose engineering as a college major. Cathy evidently has always
loved drawing and art and considered engineering to be a field in which she could apply her artistic and creative talents. Mary evidently has had a long and keen interest in the natural environment, enjoys the great outdoors and drew connections between aspects of civil engineering, particularly construction and land surveying, and the environment. Similarly, Lois strongly and repeatedly expressed how her intrigue with engineering related projects, such as bridge and road construction projects, and her enjoyment of the math that would be involved with such projects, primarily motivated her to enroll in engineering.

Finding 3. The majority of the participants perceived themselves as having high academic self-efficacies and expectations for success in engineering.

Three of the four participants, namely Cathy, Mary and Lois, perceived themselves as having strengths in the academic areas of math and science at the time when they considered choosing engineering. Cathy and Lois also considered themselves as having strong spatial reasoning skills, i.e., the ability to visualize objects in three dimensions (isometrics) and mentally rotate objects around different axes (orthographic projections).

Finding 4. The participants’ self-perceived competence beliefs and expectations for success in engineering were not leading factors that motivated any of the participants to choose engineering, but the participants considered their strengths in math, science and spatial reasoning as positive attributes to have as engineering students.

Analysis revealed that for all four participants, the subjective values they associated with engineering played a stronger role than did any competence beliefs and expectations for success they may have had when considering choosing engineering as a college major. This finding supports the Expectancy-Value Model of Achievement Related Task Choices (Eccles’ (Parsons)
et al., 1983); in particular that values can play a strong role in women’s choices of academic majors.

Finding 5. The utility subjective task value was strong enough in one participant that it may have overridden her lack of self-efficacy and expectations for success in engineering.

Kerri showed little or no self-confidence in her math and science abilities by repeatedly mentioning that she had always struggled with these topics. She also did not express as much as the other three participants that she enjoyed engineering related activities or that she was interested in them when she decided to enroll in engineering.

This participant clearly indicated that her choice to enroll in engineering was based almost exclusively on the utility value that she associated with earning her degree in engineering. The utility value that this participant assigned to earning her engineering technology degree may have outweighed the fear that she said she had of enrolling in engineering.

This finding overwhelmingly supports Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices. Eccles’ model, as applied to these findings, demonstrates that women’s low self-perceptions of their technical skills and abilities might push some women away from engineering, but the higher values that some of these women may place on becoming an engineer might more strongly pull them toward engineering.

Summary of Findings

This researcher sought to address why women, however few, choose engineering. Knowing why women at a community college chose engineering may help secondary and higher education institutions in their endeavors to motivate more women to also choose engineering. The two central research questions were:
1. How do women perceive their academic self-efficacies and expectations for success as influencing their decisions to enroll in engineering?

2. How do women perceive their subjective task values as influencing their decisions to enroll in engineering?

Academic self-efficacies/expectations for success and subjective task values constitute the two main constructs of the theoretical framework in which this research is grounded, namely Eccles (Parsons) et al. (1983) Expectancy-Value Theory of Achievement Related Task Choices. The subjective task value construct has four subcategories, and these are interest-enjoyment value, attainment value, utility value, and relative cost.

The findings from this research support the Expectancy-Value Model of Achievement Related Task Choices (Eccles [Parsons] et al., 1983); in particular, these findings demonstrate that the subjective task values that individuals attach to academic choices can play a salient role in leading individuals toward making a particular choice. The interest-enjoyment, attainment and utility subjective task values emerged from this research as being present to varying degrees in all of the participants when they were considering enrolling in engineering. Analysis of the data from this research exposed that all four participants associated their choice of engineering particularly with the interest-enjoyment or utility value that they placed on earning an engineering degree.
Chapter Five: Summary, Discussion and Implications

The findings from this research are presented in this chapter, which also includes a pattern matching logic model that compares the anticipated patterns based on Eccles (Parsons) et al. (1983) theory with the emerged patterns. This chapter also compares the research findings to the literature reviewed, discusses implications for education practice, discloses limitations of this study, and makes suggestions for further research.

Summary of Research Findings

This qualitative research study was completed at a community college and included a written questionnaire, individual face-to-face interviews and a focus group meeting to collect data from four women who had graduated from the college’s engineering program during the past six years. The analysis of this case study’s rich data, cyclically coded in accordance with Saldaña (2009), resulted in the following findings:

Finding 1. Subjective task values played a salient role in all of the participants’ choices to enroll in engineering.

Finding 2. Of the four subjective task value subcategories, the interest-enjoyment subjective task value played the primary role in the majority of the research participants’ choices to major in engineering.

Finding 3. The majority of the participants perceived themselves as having high academic self-efficacies and expectations for success in engineering.

Finding 4. The participants’ self-perceived competence beliefs and expectations for success in engineering were not leading factors that motivated any of the participants to choose engineering, but the participants considered their strengths in math, science and spatial reasoning as positive attributes to have as engineering students.
Finding 5. The utility subjective task value was strong enough in one participant that it may have overridden her complete lack of academic self-efficacy and expectations for success in engineering.

**Pattern Matching Logic Model**

Yin (2009) discusses four general strategies and five specific techniques that can be used to analyze case study data. Relying on theoretical propositions is one of the four general strategies that Yin (2009) recommends and the one that he describes as the “most preferred strategy” (p. 130). This strategy shaped the analysis of the data from this research. Pattern matching logic is one of the five specific techniques that Yin (2009) discusses and the one that he describes as “the most desirable” (p. 136). Such logic compares empirically emerging patterns with predicted patterns, according to Yin (2009), and was incorporated in this case study. The patterns to which the emerged patterns were compared were defined by the components of Eccles (Parsons) et al. (1983) Expectancy-Value Theory of Achievement Related Task Choices.

Eccles and her colleagues are leading researchers in the field of academic and occupational choice and they believe that individuals choose activities based on how well they believe they will perform the activity (academic self-efficacies/expectations for success) and the extent to which they value the activity (subjective task values) (Pintrich & Schunk, 1996; Hill, Corbett, & St. Rose, 2010; Bembenutty, 2008). Eccles et al. (1993) suggest that the values that individuals attach to doing well in different areas can play a key role in leading those individuals toward making a particular choice, and this is particularly true with regard to differences between genders in making educational and occupational choices. Eccles posits that STEM recruitment interventions based solely on improving women’s academic self-
efficacies/expectations for success in engineering, without regard to the subjective task values that these women may associate with engineering, will be ineffective (Allison & Cossette, 2007; Bembenutty, 2008; Eccles et al., 1993; Eccles, 2007; Eccles, 2011). Even women with strong academic self-efficacies and high expectations for success may not choose engineering because of the low subjective task value that they associate with the work of engineers (Eccles, 2007; Eccles 2011).

The pattern matching logic that compares Eccles’ (Parsons) et al. (1983) theory with the patterns that emerged from this research is shown graphically in Figure 5.1. From this figure it can be seen that the patterns emerging from this research support Eccles’ (Parsons) et al. (1983) theory; in particular that subjective task values can play a salient role in the process of academic choice. The shapes highlighted and outlined in bold in Figure 5.1 indicate the participants’ perceptions of what primarily motivated them to choose engineering.
Figure 5.1 Pattern matching logic model.
Discussion of Research Findings/Comparison to the Literature

Finding 1. The general finding that subjective task values played a salient role in the participants’ choices to enroll in engineering is not only consistent with what Eccles (Parsons) et al. (1983) suggest, but it also supports findings from previous research. Specifically, Matusavich, Streveler and Miller (2010) similarly found that values were very important in students’ choices to become engineers.

Moreover, Matusavich, Streveler and Miller (2010) also found that there appears to be no gray area in the attainment value that women associate with their choice to study engineering. Attainment value is one of the subcategories of the subject task value construct in Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices, and is defined as whether a person deems engineering as a good fit for him or herself. Participants in this study emerged as either able to identify with being an engineer or not at all seeing themselves someday as an engineer, which is consistent with what Matusavich, Streveler and Miller (2010) found.

However, one inconsistency between this research’s findings and the findings of that study is that the latter study identified attainment value as playing a much more prominent role in choice of academic major among its participants, than the interest-enjoyment value. This researcher has found that the interest-enjoyment value played a more prominent role in the participants’ choice of engineering as a college major.

The study by Matusavich, Streveler and Miller (2010) also differed from this research in other ways. First, those researchers primarily focused on values and did not consider competency beliefs to the extent that this study did. Second, those researchers examined the role that values may play not only in academic choice and but also the role that values may play in affecting
persistence in engineering, once the choice has been made. This research focused on choice and not persistence; nevertheless, all four participants in this research expressed their personal difficulties in earning their engineering degrees.

One participant discussed the amount of homework involved in engineering and compared herself to other students who seemed not to have struggled as much as she did. Another participant related being forced to cut back on her work schedule in order to balance raising three kids and her job as a waitress. A third participant did not appear to have struggled as much as the others, perhaps because she attended school part-time. A fourth participant revealed that engineering turned out to be harder than she expected. All four participants indicated that their struggles were worth it, however.

Third, unlike this research, Matusavich, Streveler and Miller (2010) included male participants in their study. This research has focused on only the choice of engineering as an academic major and not persistence in that major and concentrated on women’s choices only.

Nevertheless, this research suggests that subjective task values have played a salient role in all of this study’s participants’ choices of engineering as a college major, which supports Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices.

Finding 2. Of the four subjective task value subcategories, the interest-enjoyment subjective task value played the primary role in the majority of the research participants’ choices to major in engineering. Students with strong competencies in math, science and spatial reasoning may be more likely to choose engineering than students who lag behind in these areas, because students who perceive themselves as possessing those capacities may view engineering as more interesting and enjoyable, and not as rigorous and challenging, as compared to those students who do not have similar self-perceptions.
The interest in, and enjoyment of, engineering that three of the participants seemed to have embodied at the critical time in their lives when they were considering to enroll in engineering may be attributable to their competence beliefs or other things, such as the presence of role models or mentors in their lives. The effects that role models and mentors might have on an individual’s choice of academic major was an area that was discussed in the literature review chapter of this research. For example, Malicky (2003) found that women’s choices of college majors are greatly influenced by family members and high school teachers.

Two of the three participants in this study who indicated that it was out of interest and enjoyment that they chose engineering, seemed to have had positive role models or mentors in their lives. One participant mentioned that one of her high school shop teachers made her aware of the artistic sides to engineering, and that appealed to her, because she liked to draw. This participant also attended an informational session on engineering careers during which she discovered that engineering was not all about math and science; it also involved creativity, teamwork, communication and design. Being informed of these characteristics of engineering may have enabled this participant to draw connections between the subjective task values that she associated with her choice of a college major and engineering. This would support what Eccles (1993) suggests as well as what Cech (2005) recommends, namely, that in order to make headway in recruiting more female engineers, the popular image of the engineer must be challenged.

The role model in the other participant’s life may have been that participant’s own daughter, who was enrolled in an engineering program at the time when the participant was considering going back to school. The participant indicated that she was intrigued by the subject matter that her daughter was studying and saw how her daughter managed to continue to lead a
balanced life even amidst the rigor of her engineering program. This supports the findings of Milgram (2011) that women need to see how women can be successful in STEM and still have a personal life.

The third participant who seems to have also chosen engineering primarily as a result of the interest and enjoyment that she associated with engineering, did not appear to have been influenced by a mentor or role model. This participant’s interest in the environment and enjoyment of outdoor activities led her to enroll in a land surveying engineering class, which required students to participate in outdoor laboratory exercises, and evidently this was an initial step toward her completing her engineering degree.

Finding 3. The majority of the participants perceived themselves as having high academic self-efficacies and expectations for success in engineering. In particular, three of the four participants in this study reported that they have always perceived themselves as strong in math and science. Furthermore, two of those same three also considered themselves as having superior spatial reasoning skills at the time in their lives when they were considering enrolling in engineering.

Substantial literature surrounding the math and science curricula in secondary schools and whether it adequately equips female students to pursue engineering as a college major was reviewed as part of this research. One of the themes that emerged from the literature review was whether a lack of adequate math and science preparation at the secondary school level is a reason why women do not choose engineering. Some researchers have concluded that a lack of preparation at the secondary school level was not a primary reason why high school females do not choose engineering as a college major. (Malicky, 2003; Nord, et al., 2011; Shettle et al., 2007).
The data derived from and analyzed in this research supports the notion that secondary school math preparation, or a lack thereof, did not seem to affect the participants’ decisions to enroll in engineering. Three of the participants considered themselves to be strong in math and science; however, two of these three could not attribute their math skills to their high school curricula and both considered their math strengths to be innate. The fourth participant did not consider herself to be strong in math at all; nevertheless she chose engineering.

One of the participants indicated that she did not consider herself as having been born with strong spatial reasoning skills but rather having acquired those skills through the completion of a computer-aided drafting and design course in the engineering program. This directly supports what other researchers, namely Sorby and Baartmans (2000) and Agogino and Hsi (1995), have found and that is, women can acquire spatial reasoning skills through training.

This same participant who said she acquired spatial reasoning abilities also demonstrated that she may have an incremental or a malleable view of her own intelligence. Heyman et al. (2002) found that females who have a malleable view of their own intelligence are more likely to pursue STEM majors in college than those who have a fixed mindset. Females with a malleable view of their own intelligence believe that they can become smarter through learning and that their level of intelligence is not fixed. Hill et al. (2010) found that stereotypes, such as whether males are cognitively superior to females in math and science, can negatively affect a female’s perceptions of her own intelligence and therefore belief in these stereotypes may cause females to shy away from engineering.

Finding 4. The participants’ self-perceived competence beliefs and expectations for success in engineering were not leading factors that motivated any of the participants to choose
engineering, but the participants considered their strengths in math, science and spatial reasoning as positive attributes to have as engineering students.

Prior research in the areas surrounding why some women do choose engineering while others tend not to, has suggested that students who had strong competencies in math, science and spatial reasoning may be drawn to engineering because engineering programs are heavily weighted with these subjects (Agogino & His, 1995; Hill et al., 2010; Malicky, 2003; Shettle, et al., 2007; Sorby & Baartmans, 2000).

Three of the four participants in this study emerged as having strong academic competency beliefs and these same three also all indicated that they were strongly interested in, and enjoyed various aspects of engineering. This theme may be supported by the notion that people tend to enjoy things that they are good at. For two of these three participants, there seems to be a correlation between not only their interest-enjoyment and competence beliefs, but also with their attainment values. This suggests that competence beliefs and subjective task values, or at least some of the subjective task value subcategories, may not be mutually exclusive, which supports what other researchers have suggested (Agogino & His, 1995; Hill et al., 2010; Malicky, 2003; Shettle et al., 2007; Sorby & Baartmans, 2000).

Strong spatial reasoning skills have been seen to have positive effects on the gender schema, in other words the attainment value, of female engineering students. Cech (2005) found that if women see the role of an engineer as in conflict with their gender schemas, and therefore cannot see themselves as engineers, they are not likely to choose engineering as a career path. Cech (2005) studied the gender schemas of female undergraduate engineering students and found that most of them had strengths in the spatial reasoning area. Although Cech’s (2005) study included many more participants than did this research, half of the participants in this research
emerged as demonstrating both attainment values associated with engineering and competence in their spatial reasoning abilities.

Within the literature review undertaken as part of this research, the researcher highlighted how some researchers have examined the manner in which the field of engineering is portrayed to the populace and the extent to which that portrayal can affect the attainment value women associate with choosing engineering as a college major. Blaisdell (2000), the Goodman Research Group (2002) and Mattis and Sislen (2005) all suggested that female high school students are often unaware of what engineering is and this may be a reason why they do not choose engineering as a college major.

Blaisdell and Tichenor (2004) posit that interventions made before or during high school would be the most effective technique used to recruit more women into college engineering programs. The analysis of the data collected from one of the participants in this research project supports that position. This participant reflected that as an eighth grader engineering technology was scary to her. She was the only participant who enrolled in the engineering program directly after graduating from high school. She attributed her decision to enroll in engineering to her high school shop teacher in computer aided drafting who evidently enlightened her on the field of engineering and how she could apply her love of art and artistic skills in that field.

The other three participants did not choose to study engineering directly after graduating from high school; however, their discussions about their perceptions of engineers and the engineering profession supported some of the research cited in the literature review as well. For example, Cech (2005) recommends that in order to make headway in recruiting more female engineers, the popular image of the engineer must be challenged. Two of the participants expressed their negative perceptions of engineers but evidently their negative perceptions were
not enough to sway their decisions to enroll. These two participants also divulged that they were not aware of the many different concentrations and specializations within engineering from which they could choose when they decided to enroll.

During the focus group meeting, the participants disclosed that they had recently attended a seminar on women in STEM, which evidently included a panel of female speakers who were employed in engineering and appeared to be successfully balancing work and family life. The focus group participants opined that they thought it would be beneficial for other women to be given the opportunity to attend such seminars, especially during their high school years.

Eccles (1993) found that women tend to place more emphasis on the importance of helping other people and society and if they don’t perceive engineering as a profession that helps people or society, they may not choose engineering. When the participants were asked to discuss their perceptions of the engineering profession, the participants expressed that they did not perceive engineering as a profession that directly benefits people or society. Nevertheless, they chose engineering.

Finding 5. The utility subjective task value was strong enough in one participant that it may have overridden her complete lack of academic self-efficacy and expectations for success in engineering. The sole participant who perceived herself as weak in math, science and spatial skills abilities may have been pulled towards engineering based on the extremely high utility value that she associated with earning an engineering degree. Interestingly, this was the only participant who emerged as associating a high utility value with earning an engineering degree.

This may have implications for educational practice, particularly future engineering recruitment activities. Allison and Cossette (2007) stress the importance of showing females the practical utility of STEM careers. Blaisdell (2000) recommends that recruitment interventions
should focus on increasing women’s understandings of what an engineering career could do for them. Malicky (2003) found that a woman’s choice of major in college is greatly influenced by family members and high school teachers. This research did not focus specifically on the roles of mentors in the participants’ lives, but the positive influences that mentors may have had on their decisions to choose engineering did emerge from the data.

**Implications for Education Practice**

Community colleges, in collaboration with targeted and proven recruitment and retention programs, may be able to offer a solution to the mystery of the paucity of women engineers. In 2010 there were 977 community colleges in this country, representing a viable sector of education (Aud et al., 2012). According to that report, during the fall 2010 semester, community colleges enrolled over 7.2 million students and 57% of them were female. However, during the 2010-2011 academic year, women were awarded only 10% of associate’s degrees in engineering and engineering technologies from both public and private two-year colleges combined.

Eccles et al. (1993) suggest that recruitment interventions based solely on improving women’s self-perceptions of their skills and abilities, in other words their academic self-efficacies, without regard to their subjective task values, will be ineffective. This research supports what Eccles (Parsons) et al. (1983) suggest, and that is that subjective task values played a critical role in women’s educational choices. Eccles’ model, and the findings of this research, can be used to provide the basis for designing more comprehensive interventions, such as how the field of engineering is portrayed to the general public, particularly women, which might affect the subjective task values women assign to, and associate with, the work of engineers.
Women may not consider the full range of available academic options in making their choices of college majors because they may be unaware that some options even exist. Awareness for some options may exist, but these options may not be seriously considered if women have inaccurate information or misconceptions about the options. Other reasons why some options may not be seriously considered include that women may believe that they cannot be successful in those options or that the options do not fall within their gender schema. If engineering is perceived as an occupation that does not provide a good match with the values women hold, and other occupations are perceived as better matches, then even women with strong math and science skills and high expectations for success might be drawn to other fields.

Program recruiters and academic advisors should take into consideration that women may not only be unaware of what engineering is, and the assortment of specializations from which they may choose within engineering, but also unaware of the socio-benefits of being an engineer. Engineers can be considered professionals that, perhaps not directly, but ultimately try to help people. Eccles (1987) provides a relevant example when she explains that if women perceive themselves as nurturing, caring individuals they will likely choose those careers that they view as compatible with these characteristics. Women should be made aware that they can become engineers and be fulfilled in both their personal and professional lives.

The many facets of the engineering profession, including the artistic and creative sides, should be stressed, at least as much or more than the mathematical and scientific skills that have been traditionally touted as important attributes to embody if one is considering becoming an engineer. Outreach by community college engineering programs should include inquiries into potential enrollees’ interests and areas of enjoyment. Engineering should be exposed as a career
that could be a good fit for a wide variety of people and that it has many sides to it that women might find interesting and enjoyable.

One of the participants in this research suggested that middle and high school females should be told that creativity and good communication skills are what are important in order to be successful in engineering, as well as teamwork. These suggestions align with what other researchers have suggested; for instance, Allison and Cossette (2007) suggest offering hands-on workshops, during which females are allowed to work collaboratively rather than competitively, as a way of increasing their confidence in engineering.

Finally, the utility value of earning an engineering degree should not be disregarded. As found in this study, the utility value a person associates with a career can play a vital role in academic choice. The utility value that an individual associates with becoming an engineer may outweigh the trepidation that one may associate with the rigor of engineering curricula, as this research has found.

**Limitations of this Study**

A qualitative study’s transferability, in other words the applicability of its findings to other contexts, is analogous to a quantitative study’s external validity. A study’s transferability is threatened when the study’s findings cannot be generalized beyond the immediate case study. Due to the small sample size in this research, generalizing findings to a larger population may not be reasonable, one may argue. However, the engineering program is typical of engineering programs offered at other community colleges nationwide and the study’s small number of participants is representative of the national problem of the underrepresentation of females in engineering.
A qualitative study’s confirmability can be compared to a quantitative study’s objectivity. Regardless of the term applied, this describes the extent to which a study’s findings are influenced by researcher bias, motivation or interest (Lincoln & Guba, 1985). Maxwell (2005) not only warns about researcher bias, but also reactivity; the latter being the effect that the researcher may have on the participants. Miles & Huberman (1994) suggest that researchers be as explicit and self-aware as possible about personal assumptions and biases and how these may affect a study.

This researcher was aware that her professional ties to the community college’s engineering department may have affected participant responses, since the participants graduated from the engineering program. The researcher teaches engineering classes, in which some of the participants had previously been enrolled when they were students in the program. The researcher also explicitly acknowledges that she has an interest in continuing to head a healthy and rigorous engineering program. The researcher is also female, as were the participants, and may have preconceptions regarding women in engineering and the choices they’ve made. However, the researcher had no influence over the participants’ choice to enroll in engineering; all of the participants had already graduated.

The researcher allowed the participants to choose the locations for the interviews and focus group meeting, to mitigate any potential of the participants feeling intimidated and to enhance the potential of the participants providing honest answers to questions. Besides being explicit and self-aware of inherent biases, this researcher minimized bias by avoiding leading questions during data collection.

Suggestions for Further Research
Substantial research has focused on engineering students enrolled in four-year colleges and at secondary schools, yet limited research has been conducted on the factors that influence gender disparity in engineering programs at community colleges (Starobin & Laanan, 2005; Starobin & Laanan, 2008). Costello (2012) urges that research is needed to explore the factors that encourage women, particularly low-income women, to enter and succeed in STEM programs at community colleges. Beddoes and Borrego (2011) maintain that qualitative research that includes conversations with women is necessary to fill in gaps left by quantitative research studies. Matusovich and Streveler (2009) suggest that future engineering education research could greatly benefit from connecting with motivation theories, especially achievement motivation theories such as Eccles (Parsons) et al. (1983) Expectancy-Value Model of Achievement Related Task Choices. Matusovich, Streveler and Miller (2010) declare that more research is needed on engineering students’ values.

Furthermore, although much is known about why men choose engineering, little is known about the choices women make (Heyman, Martyna and Bhatia, 2002). This research has explored the reasons why some women at a community college chose engineering; but considering the small sample size included in this research, more research is needed. There is a lack of research that has adequately addressed why women enrolled at a community college choose engineering. It is important to gain insight into why women who are enrolled at a community college chose engineering as an academic and career path, because information acquired through research is an important piece in the women in engineering puzzle (Cech, 2006) and community colleges can play a vital role toward increasing the number of women engineers.

Costello (2012) identifies a number of questions that remain to be answered regarding the experiences of women in STEM programs at community colleges. One question she proposes is
whether more female role models would attract more women into STEM programs. Another question she proposes points to whether women see STEM fields as too demanding, and incompatible with their desire to balance family and work life. Both of these questions are directly related to the subjective task value construct in Eccles’ (Parsons) et al. (1983) Expectancy Value Theory of Achievement Related Task Choices. This researcher agrees and further suggests that research be conducted within engineering programs at other community colleges to confirm reasons why some women do choose engineering.

**Conclusion**

It is a fact that women are underrepresented in college engineering programs, and subsequently in the engineering profession. Data reveals how women historically have been underrepresented in undergraduate engineering programs in colleges across the entire country and even globally (National Science Foundation, National Center for Science and Engineering Statistics, 2011; Gill, Sharp, Mills & Franzway, 2008).

There are many reasons why the underrepresentation of women in engineering is a problem, regardless of whether the phenomenon is occurring at a local, national or global level. One reason is that women are missing opportunities to earn rewarding salaries that engineering professions typically provide, as well as opportunities to contribute their personal and professional expertise toward the many specific disciplines within the field of engineering. The underrepresentation of women also affects the engineering profession because engineers are professionals that ultimately try to benefit people through their work, and as others have pointed out, the engineering profession can only gain if its workforce is as diverse as the people that it serves (Chubin, May & Babco, 2005).
Researchers have looked at the problem from a variety of perspectives (Goodman Research Group, Inc. 2002; Hill et al., 2010; Malicky, 2003). They have analyzed statistics concerning the academic preparedness of high school female students, compared cognitive abilities across genders, studied stereotype threats and their effects on females’ self-efficacies, critiqued how STEM is portrayed, and investigated the role of community colleges in producing more engineers.

Many recommendations that are being made concerning how to attract more women into engineering college programs are based primarily on increasing women’s self-perceptions of their skills and abilities (Allison & Cossette, 2007; Eccles et al., 1993). Eccles (1993) posits that recruitment interventions should not be based solely on increasing women’s competence beliefs. She suggests that even women with strong academic self-efficacies and expectations for success in engineering, might not choose engineering as a college major if they do not associate strong personal values with earning an engineering degree. If the phenomenon of why some women do choose engineering is understood, then perhaps that knowledge can be incorporated into future recruitment activities that aim to attract more women to enroll in engineering, and those recruitment activities might be more successful in their endeavors.

Eccles’ (Parsons) et al. (1983) Expectancy Value Model of Achievement Related Task Choices is a model that concentrates on choice rather than avoidance, as opposed to other models that are used to compare women to an ideal male standard and to study why women choose not to achieve like men (Eccles, 1986). Eccles posits that women’s decisions not to engage in an activity, such as enrolling in an engineering program, may reflect their choices of alternate activities, rather than avoidance.
This researcher aimed to investigate and contribute to the current knowledge surrounding the problem of the lack of women in engineering, by collecting and analyzing qualitative data from females who graduated from a two-year engineering program at a community college in the northeastern U.S., and concentrated on their perceptions of their choice of academic major.

The literature review revealed that, although much is known about why men choose engineering, little is known about why women make the academic choices they do. In addition, most research surrounding the underrepresentation of women in engineering and their academic choices has occurred at secondary schools and four year colleges and universities. Prior research has not adequately addressed why women enrolled at a community college choose engineering. An understanding of women’s choices to enroll in engineering will be useful in the design of future recruitment and retentions efforts.

Framed by Eccles’ theory, this researcher has found that subjective task values did in fact play a predominant role in all of the participants’ choices to enroll the engineering program. Moreover, the patterns emerging from this research and the relationship to the theoretically predicated patterns have suggested that the participants’ decisions to enroll in engineering, for the majority of the participants, were primarily influenced by one particular subjective task value, and that is interest-enjoyment. The interest in, and the enjoyment that the participants associated with, engineering related subject matter primarily motivated the majority of participants to choose engineering.
References


Dear _____________:

I am inviting you, and other women who have graduated from BCC with a degree in engineering, to participate in a research study that aims to find out why so few women choose engineering as compared to men. The research study, which is called Understanding Women’s Choices To Enroll in Engineering: A Case Study, is part of an educational program that I am enrolled in at Northeastern University. Women choose engineering for a variety of reasons and this research aims to identify particular events, people or experiences that have influenced their decisions.

Your participation in this study is completely voluntary. If you do decide to participate, I will send you a questionnaire that will ask you ten questions about why you chose engineering. After I receive your completed questionnaire, I would like the opportunity to meet with you for about one hour, so that I can learn more about those events, people or experiences that had influence on your choice. We can meet at a location on a day and time that is convenient for you. I will also ask you to participate in a one hour group meeting with all participants, which will provide an opportunity for all the women involved in the study to get together to discuss the reasons why they chose engineering. The group meeting will take place on BCC’s campus at a mutually agreeable day and time. If the participants agree, I would like to audiotape these meetings.

There are no costs, foreseeable risks or direct benefits to you if you choose to participate in this study. However, this study may contribute to the understanding of why so few women as compared to men choose engineering. Women are missing opportunities to earn rewarding salaries that engineering careers typically provide. They are also missing opportunities to contribute their personal and professional expertise toward the many specific disciplines within the field of engineering.

For purposes of privacy, I am the only person who will see your questionnaire responses and the only person who will meet with you and the other participants. Your part in this study will be confidential. Pseudonyms will be used to keep all participants and BCC anonymous. For instance, participants will be referenced as “Participant A”, “Participant B”, etc., and BCC will be referred to as “The Community College”. No reports or publications will use information that can identify you in any way. Even if you begin the study, you can refuse to answer any question and you may quit at any time. If you do not participate or if you decide to quit, you will not lose any rights, benefits, or services that you would otherwise have as a BCC graduate.

If you have any questions about your rights in this research, you may contact Nan Regina, Director, Human Subject Research Protection, 960 Renaissance Park, Northeastern University Boston, MA 02115-5000. Tel: 617.373.4588. Email: n.regina@neu.edu. You may call anonymously if you wish.
If you do decide to participate, please reply to this email at young.ei@husky.neu.edu no later than September 8, 2013 and I will send you the questionnaire. When we meet for an interview, I will ask that you sign this form below I will give you a copy to keep for your records.

If you have any questions, please do not hesitate to ask me. I hope you consider participating in this research study that aims to contribute to our knowledge of why so few women as compared to men choose engineering.

Sincerely,

Eileen Young
Doctoral Student at Northeastern University

I agree to take part in this research.

_______________________________________ _____________
Signature of Person Agreeing to Participate  Date

______________________________________ ____________ _
Printed Name of Person Signing Above  Date

_______________________________________ ___________ __
Signature of Researcher     Date

_______________________________________ ___________ __
Printed Name of Researcher     Date
APPENDIX B

QUESTIONNAIRE

1. Please describe when and how you first became interested in engineering.

2. How would you describe your academic skills, particularly in math and science, as compared to other people that you know?

3. Do you think that your math and science skills largely contributed to your decision to choose engineering, or are there other things that had more influence on your decision?

4. Perhaps many things influenced you to enroll in engineering. If you had to list just one reason why you chose engineering, what would it be?

5. If you had to describe yourself, which are you more likely to say: that you are good at engineering or that you enjoy engineering, and why?

6. Suppose you were a high school guidance counselor. How would you describe the field of engineering to your advisees?

7. Do you think more women should consider engineering as a major, and if so, why?

8. Do you think that engineering is a good fit for you, and why or why not?

9. Are you currently working in the field of engineering? If so, please describe what you do.

10. Please list any additional comments you might have about why you chose engineering.
APPENDIX C

RESPONSES TO QUESTIONNAIRE

CATHY

1. Please describe when and how you first became interested in engineering.

I first became interested in engineering in 2004; when I was accept to Bristol-Plymouth Regional Technical High School and the shop teacher (Mr. Borges) told me about his shop. So, I tried it and loved it.

2. How would you describe your academic skills, particularly in math and science, as compared to other people that you know?

I have always excelled in math, and did well in science. Compared to some of my friends, my math skills especially were better.

3. Do you think that your math and science skills largely contributed to your decision to choose engineering, or are there other things that had more influence on your decision?

My math skills did play a small role, but my love of drawing and my attention to detail really played a much bigger role.

4. Perhaps many things influenced you to enroll in engineering. If you had to list just one reason why you chose engineering, what would it be?

Mr. Borges, my former teacher. He showed me engineering was not all about math, science, and technology.

5. If you had to describe yourself, which are you more likely to say: that you are good at engineering or that you enjoy engineering, and why?

I enjoy engineering. I can use learned such as: skills to design, make, interpret. I also use other skills to get others, especially girls, interested in engineering. Those skills I did not learn, but already had.

6. Suppose you were a high school guidance counselor. How would you describe the field of engineering to your advisees?

I would describe it as hard work, but rewarding work.

7. Do you think more women should consider engineering as a major, and if so, why?

I definitely do, especially upon graduating with 6 women in my class of 55. Women bring a different set of skills to engineering, which makes a team projects behave differently.
8. Do you think that engineering is a good fit for you, and why or why not?

I do think it is a good fit. I can use my knowledge gained from schooling, work, and personal experiences. But I can also use my love of art to aid in designs and interpretation of other people’s designs.

9. Are you currently working in the field of engineering? If so, please describe what you do.

I am not currently working in industry.

10. Please list any additional comments you might have about why you chose engineering.

I also chose engineering to make a difference for women in high school and middle school by participating in community outreach.

MARY

1. Please describe when and how you first became interested in engineering.

I took an introductory computer class. I liked it so I took more computer classes, and completed one small certificate and began taking classes for a larger certificate. At some point I got cold feet about the computer classes in the CIS department so I made a sideways move into CAD classes in the engineering department. It was another way to design things on a computer. After a few semesters I ran out of CAD classes and I had to think of something else to study. Surveying seemed like it would be a lot of fun, so that’s how I got into engineering.

2. How would you describe your academic skills, particularly in math and science, as compared to other people that you know?

My academic skills in math and science are above average.

3. Do you think that your math and science skills largely contributed to your decision to choose engineering, or are there other things that had more influence on your decision?

I’m sure having solid math and science skills made it seem non-intimidating to take engineering classes. But I really made the decision based on interest.

4. Perhaps many things influenced you to enroll in engineering. If you had to list just one reason why you chose engineering, what would it be?

My background is in science, especially biology. Engineering was intriguing to me because it uses scientific principles to do useful things.

5. If you had to describe yourself, which are you more likely to say: that you are good at engineering or that you enjoy engineering, and why?
I’m more likely to say that I enjoy engineering, because I don’t specifically use it in my work. I do make use of principles I learned in engineering classes sometimes, in my job and in life.

6. Suppose you were a high school guidance counselor. How would you describe the field of engineering to your advisees?

I would say that engineering is challenging and interesting. There are a lot of different types of engineering and a lot of different things that someone could do with an engineering degree.

7. Do you think more women should consider engineering as a major, and if so, why?

I definitely think more women should consider engineering as a major, especially students who are able to succeed in math and science classes. There are a lot of jobs in engineering, and since women engineers are in the minority, job prospects are good for qualified female applicants.

8. Do you think that engineering is a good fit for you, and why or why not?

I think it’s a great fit for me. I just wish I could use it more, but the thought structures I developed in engineering classes will always serve me well.

9. Are you currently working in the field of engineering? If so, please describe what you do.

I’m not working in the field of engineering, but I work in a related field. I work as a lab technician for the department of natural sciences at BCC.

10. Please list any additional comments you might have about why you chose engineering.

I took the classes for fun and out of curiosity.

LOIS

1. Please describe when and how you first became interested in engineering.

I first became interested in engineering approximately 3 years ago. My youngest daughter was attending UMD, majoring in civil engineering and I would question her about her coursework and her goals. I was intrigued by the subject matter. I saw how difficult the material was, but also how she balanced her social and work life around the academics. As we talked, I realized that I could picture myself in the field of engineering.
2. How would you describe your academic skills, particularly in math and science, as compared to other people that you know?

I am remarkably strong in both disciplines and would consider myself in the top 10 percentile. If I had not taken such an extended break from school to raise a family, I would say top 5%.

3. Do you think that your math and science skills largely contributed to your decision to choose engineering, or are there other things that had more influence on your decision?

Those skills were definitely a contributing factor, because they align with my interests and curiosity.

4. Perhaps many things influenced you to enroll in engineering. If you had to list just one reason why you chose engineering, what would it be?

I envisioned having a career that would challenge me and keep me interested with the opportunity to further my education.

5. If you had to describe yourself, which are you more likely to say: that you are good at engineering or that you enjoy engineering, and why?

I would say that I enjoy engineering. I strive for excellence at everything I do.

6. Suppose you were a high school guidance counselor. How would you describe the field of engineering to your advisees?

I would say that it is a career that can be challenging and rewarding. It is a diverse field which should only grow in the future. The field was once male-dominated, but the emergence of capable women entering the field is expanding. Lastly, it is a career that can offer some financial security.

7. Do you think more women should consider engineering as a major, and if so, why?

Yes, because women need to think about the job market and financial security.

8. Do you think that engineering is a good fit for you, and why or why not?

It is a good fit because I am capable and challenged to continue learning more.

9. Are you currently working in the field of engineering? If so, please describe what you do.

No

10. Please list any additional comments you might have about why you chose engineering.

I often wonder if I chose engineering or if engineering chose me!
1. Please describe when and how you first became interested in engineering.

I first became interested in engineering while I was renovating my own real estate projects. Every time I began a project I needed a civil engineer in one way or another, which always seemed to delay my projects. I felt that if I had some knowledge of the field I could speed along the delays and help to grow my partner’s construction company. At the time however, I had my own business that was in an industry completely unrelated to both fields. I left that industry to work from home as a real estate sales agent. Almost every transaction I was involved in needed a surveyor, someone to inspect or design septic plans, structural engineers to inspect properties that had been poorly renovated or to approve the designs for a buyer or contractor, etc.

2. How would you describe your academic skills, particularly in math and science, as compared to other people that you know?

I had always struggled with math and science in school as an adolescent but I became more interested in them as an adult. My time in business helped my math skills but there were many gaps in my education. Math and science do not come as easy to me as many other subjects but I find that I am more interested in topics that I have difficulty with.

3. Do you think that your math and science skills largely contributed to your decision to choose engineering, or are there other things that had more influence on your decision?

My math and science skills or lack thereof actually scared me the most in my decision to choose engineering. I was actually concerned with my choice in engineering as a major until I took a career questionnaire from The Career Center, it actually resulted in engineering being the best fit for me based upon my interests.

4. Perhaps many things influenced you to enroll in engineering. If you had to list just one reason why you chose engineering, what would it be?

My partner and children influenced me the most to enroll in engineering. After working many hours away from them for so many years, I wanted to do something that would bring me closer to them while working at the same time. We have been self-employed for many years and work is a big part of home life.

5. If you had to describe yourself, which are you more likely to say: that you are good at engineering or that you enjoy engineering, and why?

I'm not sure if I can say that I'm good at engineering. I have enjoyed the classes I take to become an engineer. Some of the classes definitely are easier for me than the others.

6. Suppose you were a high school guidance counselor. How would you describe the field of engineering to your advisees?
I am still learning that myself. I have only one view of engineering and as I am exposed more to
the field, I am finding more "specialties" that I was completely unaware of. I do know that
anyone who puts their mind to the subjects involved, can get through them with work and time.

7. Do you think more women should consider engineering as a major, and if so, why?

I think more women should consider engineering. I don't believe one gender or another is more
fit for any career. Engineering wasn't even considered when I was in college after high school. I
wasn't aware of it at all.

8. Do you think that engineering is a good fit for you, and why or why not?

I am a very creative person and I really enjoy appreciating most buildings and properties as a
whole. Many times I look at something someone has built and I either absorb their great designs
and/or ideas for improvement come flooding to mind. In most "creative" fields or at least the one
I was in, you are alone to make someone's vision a reality where in engineering it's more of a
group project.

9. Are you currently working in the field of engineering? If so, please describe what you do.

I am not currently working in the field of engineering. I am back in school pursuing my
bachelor's degree.

10. Please list any additional comments you might have about why you chose engineering.
APPENDIX D

INTERVIEW OUTLINE

PURPOSE: The purpose of this interview is to discuss your responses to the questionnaire and provide you and I with an opportunity to elaborate further on why you chose engineering and your perceptions of the program.

DATE: __________

LOCATION:

INTERVIEWEE: _______________________

DURATION: 60-90 Minutes

The researcher will inform the participant that she would like to audio record the interview so that she can have repeated access to the data, and once the data is transcribed, the audio recording will be erased.

DISCUSSION POINTS:

1. Please elaborate on when and how you first became interested in engineering.

2. Before you enrolled in engineering, did you consider enrolling in other programs, such as nursing or other health sciences? If so, what attracted you to those programs and why did you ultimately choose engineering?

3. What do you like most about engineering so far? What do you like the least?

4. Has engineering turned out to be what you thought it would be like?

5. Would you like to see more women in engineering?

6. Why do you think so few women choose engineering as compared to men?

7. What would you tell other women about engineering now that you are an engineering student?

8. Do you think that it is important for engineering students to have really good math skills in order to be successful?

9. Do you think the engineering field does a good job at promoting the profession?

10. What could colleges do differently to attract more women to engineering?
APPENDIX E

FOCUS GROUP OUTLINE

PURPOSE: The purpose of this focus group is to give all participants in this study an opportunity to get together as a group and share common perceptions and experiences as women in engineering.

DATE: ____________

LOCATION: ____________

PARTICIPANTS:_________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_____________________________________________________

DURATION: 60- 90 Minutes

DISCUSSION POINTS:

1. The researcher will remind the participants that she intends to audio record the focus group discussion and ask whether anyone objects. The researcher will explain that the purpose of audio recording is to allow the researcher to have repeated access to the data and once the data is transcribed, the researcher will erase the recording.
2. The researcher will open the discussion by asking the participants to share whether engineering turned out to be what they thought it would be like.
3. The researcher will ask the participants to share with each other why they chose engineering.
4. The researcher will identify the most common reason reported and open this up for discussion.
5. The researcher will discuss reasons why women may be drawn to other fields and ask the participants to comment on this. For instance, women may be drawn to the health sciences because they see those fields as ones that primarily help other people. Perhaps they do not see engineering as a field that also helps people.
6. The researcher will ask whether the participants think engineering needs a marketing overhaul.
7. The researcher will ask the participants to share their ideas regarding how more women could be recruited into engineering.
APPENDIX F

FIRST AND SECOND CYCLE CODES

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