ABSTRACT

DININ, ALESSANDRA JAYNE. An Exploration in Theory of the Storied Experiences of Women Earning Engineering Bachelor's Degrees at a Southern, Research, Predominately White Institution. (Under the direction of Audrey J. Jaeger and Joy G. Gayles).

This dissertation study explores the experiences of 11 undergraduate women in a variety of engineering majors graduating from a Southern, research, predominately White institution and the use of theory to understand those experiences. While narrative inquiry is used throughout, this dissertation study is organized into three separate papers. The first paper acknowledges feminist standpoint theory's influence in considering the experiences of women in engineering as unique and inferior to that of men, but it is not designed by theory. From the interviews from this first study, the women's narratives demonstrated sexism, self-doubt and feeling like an imposter, enacting a growth mindset, and using engineering to do good. The second paper is framed by Jaeger, Hudson, Pasque, and Ampaw's (2017) life experiences and role negotiations (LEARN) model and it illustrates that the LEARN model is a useful theoretical lens through which to consider the experiences and trajectories of undergraduate women in engineering. In this paper, the women's stories are organized around the components of the LEARN model: continuous personal determinants, the environment, past determinants, learning, present determinants, decisions, and future career outcomes. The third and final paper explores how theory is being used in recent higher education research to understand the experiences of undergraduate women in engineering. The third paper also compares the first two papers' analytical codes using constant comparative analysis to understand if using a theory throughout the design of a study affects the shared narratives of the 11 women or the researcher's analysis of them. Taken together, all three papers suggest improvements to their study designs as implications for future

research. Implications for theory include suggestions for the application of the LEARN model and theory in general when considering the experiences of undergraduate women in engineering. Implications for practice identify ways in which universities, industry partners, faculty, students, and staff can improve the experiences of women in engineering.

An Exploration in Theory of the Storied Experiences of Women Earning Engineering Bachelor's Degrees at a Southern, Research, Predominately White Institution

by
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DEDICATION

To Aaron and Adeline.

I’ve learned that each moment is a gift, and I am so blessed and grateful for each moment with you.

BIOGRAPHY

Alessandra Jayne Dinin (née Hayden) was born in Ascot, United Kingdom—yes, the home of the thoroughbred horse racecourse. Although twenty-five years later she met her partner, Aaron, at a Kentucky Derby Party in Alexandria, Virginia, she has not been to a horse race, nor does she have any special affinity for horses. Besides England, Virginia, and North Carolina, Alessandra has also lived in Japan, Washington, D.C., and California.

While in California, Alessandra earned a Bachelor of Arts in Global Studies with an Emphasis in Socioeconomics and Politics from the University of California, Santa Barbara. During her undergraduate degree, Alessandra worked for the American Red Cross, and after graduation, Alessandra went to work for the National Multiple Sclerosis Society. Her next employment position was at the American Society of Engineering Education (ASEE) in Washington, D.C. While working at ASEE, she earned her Master of Arts in Education and Human Development from the George Washington University.

Pursuing her Ph.D. in Educational Research and Policy Analysis (Higher Education Administration concentration) brought Alessandra to NC State University. While at NC State, Alessandra worked as the Research Director for the National Initiative for Leadership and Institutional Effectiveness (NILIE). Towards the end of her degree, she accepted a position as a research analyst for the Office of Assessment, Trinity College at Duke University where she still works today. She enjoys living in Durham, NC with her partner, Aaron, their daughter Adeline, and Tate, their Wheaton Terrier.

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Lastly, a special acknowledgement to the people who were so very special to me in life, who passed away during my time in the Ph.D. program, to my Grandma Muriel, my father-in-law Lenny, my Auntie Vi, and my dear friend Debola. I hope you all know how much happiness and love you brought me. Also, to Dawn Crotty and Trae Brookins, our time together at NC State may not have been long, but your presence and influence in my life was far-reaching.

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PREFACE

This dissertation study is organized into three separate articles. All three articles are intended to stand alone although they address similar topics—the experiences of undergraduate women in engineering and the use of theory in considering these experiences.

In the first article, "You're probably going to be the only female and they might not respect what you have to say: A narrative inquiry of engineering undergraduate women," the storied experiences of 11 women are explored to illustrate the experiences of undergraduate women graduating with degrees in engineering from a Southern, top-tier research, Predominately White Institution (PWI). This topic is framed in Feminist Standpoint Theory and supporting literature highlights discussions about STEM Ability and Climate and Gendered Biases in the field. Four main themes emerged: sexism in engineering, imposters, overcoming gut checks (enacting a growth mindset), and women engineer a better world.

The second article, "A Narrative Exploration of the LEARN Model: Understanding the Learning and Career-Seeking Experiences of Women Earning Engineering Bachelor's Degrees," considers whether the LEARN model is a good lens through which to understand the experiences of women in engineering. The same 11 participants participated in a second, separate interview to generate the data for this inquiry. Supporting literature addressed the theoretical underpinnings of the Life Experiences and Role Negotiations (LEARN) Model, and participants' stories are organized and presented around the various components of the model. Then, based on the participants' stories, a new iteration of the model is proposed.

The third and final article, “Is Theory Needed to Explore the Narratives of Undergraduate Women in Engineering at a PWI?,” investigates the utility of a theoretical lens in exploring the storied experiences of undergraduate women graduating with a degree in engineering. This paper is organized into three parts: part one includes a theoretical meta-analysis of the literature to understand the importance of theory to this field; in part two, two parts of a qualitative study (the previous two articles of this dissertation study)—one part driven by theory and one part not—are compared in order to determine if engineering undergraduate women’s narratives differ when theory is central to the study’s design; and, finally, part three of this paper draws conclusions regarding the results of the comparison (part two) and how these results fit into the use of theory in the field (part one).

YOU'RE PROBABLY GOING TO BE THE ONLY FEMALE AND THEY MIGHT NOT RESPECT WHAT YOU HAVE TO SAY: A NARRATIVE INQUIRY OF ENGINEERING UNDERGRADUATE WOMEN

Over the last few decades, various national programs, services, and policymakers in the United States have tried to increase the number of people pursuing careers in science, technology, engineering, and mathematics (STEM). For example, early in his presidency, President Obama presented a cross-agency priority goal to increase the number of STEM bachelor's degree earners by 1 million. His rationale for this priority is that he considered science and innovation to be a cornerstone of a strong national economy (Feder, 2012). In 2015, President Obama re-engaged this goal by committing over $240 million to new STEM programs and services (The White House, 2015).

In some STEM disciplines, like biosciences and mathematics, the number of people in the fields increased steadily over the last few decades, and groups identified as underrepresented in STEM, like women, have a larger foothold (NSF, 2015). However, in other STEM disciplines, like engineering, the proportion of students pursuing an engineering bachelor's degree or entering the engineering workforce is decreasing, and the number of students from underrepresented groups is less now than ten years ago (NSF, 2015). In light of this uneven growth, this article suggests that instead of initiatives that address the overall STEM workforce, more must be done to increase the representation of women in engineering careers, and learning more about women's experiences in engineering, hearing their stories, can help identify what needs to be done.

In 2012, 33.5% of female freshman and 45.8% of males intended to major in a STEM field, but these proportions decreased to 3.9% and 18.3% respectively when only considering freshman intending to major in engineering (NSF, 2014). In some STEM disciplines, the proportion of women earning bachelor's degrees was much higher in 2012 (biosciences 58.2% and mathematics 43.1%). When combined with all STEM fields, these well-represented segments hide the inequalities in other disciplines, like engineering, physics, and computer science that have particularly low proportions of women. Only 19.1% of physics bachelor's degree earners, 18.2% of computer science, and 19.2% of engineering bachelor's degree earners are women (NSF, 2015).

Specifically, in regard to engineering bachelor's degree earners, the 19.2% of engineering students that identified as women in 2012 is lower compared to 20.9% in 2002 and higher than the 15.9% in 1993 (NSF, 2015). The proportion of women in engineering degrees decreased slightly in the last ten years, but this bachelor's degree completion rate is also skewed when considering specific engineering disciplines. For example, in 2012, the proportion of women in engineering was higher in chemical, materials, industrial, and civil engineering than it was in aerospace, electrical, and mechanical engineering, but remained far below the proportion of men (NSF, 2015). In addition to the low proportion of engineering bachelor's degree earners across all engineering degrees, in 2013, the proportion of women in engineering occupations (postsecondary teacher and aerospace, chemical, civil, electrical, industrial, mechanical, and other engineers) dropped to 14.8% (NSF, 2015).

Decreasing numbers of engineers are problematic because engineers play an increasingly critical role in society. For example, increases in the human lifespan and quality of life are attributed to advances in biotechnology, such as, increasing the human genome database, tissue engineering, regenerative medicine, noninvasive surgical techniques and equipment, drug delivery, prosthetic devices, and implantable medical devices. Additionally, engineers facilitate gains in information and communications technologies in terms of computer device size, capacity, and speed. They also support safety and security endeavors whether through cyber security or addressing anticipated shortages in drinkable water (National Academy of Engineering, 2004).

Women's underrepresentation in STEM and, especially engineering, is more significant than quotas, proportions, or percentages. Increasing women's representation in engineering fields will not only increase overall numbers but it will add much needed diversity to the field, making it more competitive, healthy, and comprehensive (Blickenstaff, 2005; Hill, Corbett, & St Rose, 2010; Shapiro & Sax, 2011). Women's representation is directly connected to the aforementioned societal benefits, wherein previous male-dominated teams have made products that's benefit or functionality is limited to men. For example, mostly male teams created the first iteration of automobile airbags to fit adult males, which resulted in unnecessary deaths of women and children (Margolis & Fisher, 2003). Another mostly male team designed an artificial heart valve to only fit men's hearts (Margolis & Fisher, 2003). Then, with less fatal consequences although equally symbolic, another team pioneered voice recognition software that was calibrated to men's voices, leaving women unheard (Margolis & Fisher, 2003).

Engineers, overall, also get paid more than people in other fields, introducing additional economic benefits as a reason why more people, especially women, should pursue an engineering career. The U.S. Census Bureau (2012) predicts that an engineering bachelor's degree holder has a projected lifetime earnings of $3.349 million—the highest earning potential of any bachelor's degree. In comparison, a business bachelor's degree holder is projected to earn $2.563 million, a physical sciences degree earner $2.527 million, a literature degree earner $2.083 million, and an education bachelor degree earner $1.798 million (U.S. Census Bureau, 2012). For further comparison, the difference in projected lifetime earnings for an individual with a high school diploma and an individual with a college degree is about $1 million (Julian, 2012). In 2013, on average, women that worked full-time earned only 78 cents to every dollar earned by a man (Council of Economic Advisers, 2015). In engineering, this proportion increases to 82 cents for a woman to every dollar earned by a man (AAUW, 2015). If more women earn engineering degrees and enter the engineering workforce, then, based on their degree, they would make more than other women, and they would be slightly closer to their male counterparts' salaries.

Furthermore, as to why women should be equally represented in engineering and why studies like this study are important, Franzway, Sharp, Mills, and Gill (2009) explain:

> The taken-for-granted answer is that women should be equal in all areas of society, so they should have equal access to engineering education and to all levels of the

> profession itself. Since engineering appears to be an entrenched area of male dominance, such a goal is particularly compelling. However, we argue that the underlying assumptions about the problem and associated gender equity policies and campaigns at national and international levels need to be addressed. The key to these assumptions lies with the avoidance of gendered power relations, which we term "sexual politics" (Franzway, 2001). Sexual politics is useful for recognizing the everyday denial of gender that takes place within the complex gender relationships of power as domination, resistance, alliances, and pleasures that are central to all social institutions, including engineering organizations. When the relevance of gender as a cause or explanation for the absence of women from the central concerns of work and cultural change is denied, it is not just a matter of ignorance or carelessness. Rather, it is a clear sign that a non-egalitarian sexual politics that advantages men is in play (p. 91).

Women should be equally represented in all facets of society, and where women are not equally represented, there is evidence of "gendered power relations," or "sexual politics" (Franzway, 2001), or dominance, resistance, and alliances on the part of men. Adding more women to an arena does not mitigate these "sexual politics." To Franzway et al.'s point (2009), more work is needed to understand how "gendered power relations," or "sexual politics" (Franzway, 2001), affect women's engineering opportunities and experiences. Understanding and improving upon these opportunities and experiences is critical for everyone.

Given the societal importance and need for women engineers and the inequities women face from their underrepresentation in engineering, the purpose of this narrative study is to better understand the experiences of undergraduate women graduating with degrees in engineering from a Southern, top-tier research, Predominately White Institution (PWI). This study offers new insights and best practices from women who are months away from successfully completing their engineering degrees. These insights and best practices can help other women and, as a result, potentially increase women's persistence in engineering. This study's findings also serve to inform policymakers' decisions regarding how to best allocate funding for k-20 and undergraduate programs and services geared towards increasing the numbers of women prepared to enter the engineering workforce.

Feminist Standpoint Theory

By choosing to explore women's narratives about engineering to improve their experiences, I am highlighting that women's experiences are different and inferior to that of male engineering students. While this narrative inquiry focuses on an emic research question, "what are the experiences of women in engineering," from the storied experiences of the women and not the interpretation of myself, the researcher, it is framed in feminist theory. According to McCann and Kim (2017), "feminist theories… provide intellectual tools by which [we] can examine the injustices [women] confront and build argument to support their particular demands for change" (p. 1). Of feminist theories, feminist standpoint theory utilizes women's experiences to communally construct knowledge. "Standpoints" are developed through critical reflection on the effects of power structures and resulting social locations (Intemann, 2010). Following Intemann's (2010) logic and an example, a female student may consider sexual harassment by a male professor trivial, accidental, or deserved, but when multiple women in a class have the same experience, through their validation and shared experience the "standpoint" is formed. This assumption of a communal "standpoint" is contentious because, while women have common experiences, there are also differences when gender intersects with race, class, sexuality, and nation (McCann & Kim, 2017).

Feminist standpoint theory has two central tenets: social location, or where we are in a societal hierarchy or plane, forms and limits knowledge (Intemann, 2010; Wylie, 2003); and, the standpoints of marginalized groups are "epistemically advantaged" (Intemann, 2010; Wylie, 2003). Social location forms and limits knowledge because we may not be privy to all knowledge based on our positions. For example, a student may not have access to the same knowledge as a professor, but her place in the professor's class shapes her knowledge. The professor has more content knowledge than the student, but the student learns different things than she might in a different class taught by a different instructor or with different classmates. The later point regarding "epistemically advantage" suggests that marginalized or oppressed groups can understand the knowledge/experience of the dominant group because they live in a society that is shaped and driven by the dominate group. Whereas, dominant groups cannot understand the knowledge/experiences of marginalized groups because there are few opportunities to do so. For example, there are few opportunities for men to critically reflect on or engage with the experiences of women in engineering because the time and space is not made to do so, outside of rare, one off diversity trainings. Landau

(2008) challenges these assumptions indicating as to the first tenet, that men and women have some shared experiences, for example, they might participate in the same difficult class, and to the second tenet, that marginalized groups do not always have an epistemological advantage—there are some things that women engineering students might not understand about male engineering students. Men and women may have shared "experiences" in the general sense of the world, like taking the same difficult engineering courses, but women's *experiences* in these courses and the meaning-making pertaining to these experiences are influenced by their gender, and therefore different. In regard to the second critique, while women may not always have a knowledge advantage generally, they do have a knowledge advantage when it comes to understanding the experiences of women in engineering, which is the focus of this study.

Kournay (2009) highlights the disadvantage of omitting standpoint theory from the sciences: "science is a patriarchal institution… [pointing] to masculinist personal and social and political and economic interests and values that influence or virtually determines its outcomes" (p. 212). Similar to Margolis and Fisher's (2003) examples of oversight discussed in the introduction, Kournay (2009) explains that "good science" should not have allowed the oversight of omitting women in the study of heart disease, wherein in the 1990s, heart disease was studied and promoted as a male disease while it is also the number one killer of women. Discounting or not including the standpoint of women led to them being omitted from this early heart disease work.

To understand women's experiences in engineering, we first recognize that their standpoints are important. The literature review below justifies the need for engineering women's standpoints. Then, after establishing their value, the women's standpoints about engineering can be used to understand and improve upon their experiences.

Literature Review

Women's underrepresentation in STEM degree programs, and eventually the STEM workforce, has been explored in depth in extant literature. A limitation within this body of literature is the infrequent disaggregation of engineering fields from STEM, when the statistics detailed in the previous section demonstrate the experiences of women in engineering must be assumed to be distinct from other disciplines, like bioscience and mathematics (Sax et al., 2016). To illustrate this point in a contradictory way, George-Jackson (2011) argues, "by using a broad definition of STEM, [her] study provides evidence of women's participation and representation in the STEM fields, which disputes commonly accepted notions that too few women persist in science majors" (p. 165). She includes a broad definition of STEM fields so as to not diminish the scientific merit or contribution of women participating in different disciplines than "high profile" STEM fields like computer science and engineering (George-Jackson, 2011, p. 153). When George-Jackson (2011) groups agricultural and biological sciences and health sciences and psychology with physical science, computer science, math, and engineering, she finds women's representation in STEM fields increases and the gender gap between women and men decreases. While George-Jackson (2011) indicates that grouping more STEM disciplines together will help show that women are doing well overall in STEM, this study suggests that, in contrast, a better route to represent the gains, and more importantly any losses, in specific STEM fields is to disaggregate them.

STEM Ability

Women's underrepresentation in STEM has also been attributed to innate, biological differences. These innate, biological differences and the idea that women are not as smart as men have been discredited (Goldman, 2012; Viadero, 2009; Yauch, 1999); however, gender differences around visual-spatial abilities, which are linked to engineering, have been widely debated (Voyer, Voyer, & Bryden, 1995). In an attempt to settle the debate, in their meta-analysis, Voyer, Voyer and Bryden (1995) find that women and men do have different spatial abilities. Nevertheless, even if spatial abilities vary by gender, Valian (2007) introduces incremental theory to suggest that STEM skills and traits are not set; they can be learned and developed.

Like incremental theory suggests, seeking and facilitating opportunities of learning and development are akin to growth mindset principles. For Math and Science ability, Carol Dweck (2008) posits that students who have a growth mindset, "believe that their abilities can be developed" and are at an advantage as opposed to students with a fixed mindset, or the belief that one's "intelligence or math and science ability is simply a fixed trait" (p. 2; Dweck, 1999). A fixed mindset is problematic because students with it seem to shy away from putting forth effort, they don't bounce back from challenges, and they value looking smart at the expense of trying new things or seeking out new opportunities to learn (Dweck, 2010). This fixed mindset is also linked with negative behaviors like cheating (Blackwell, Trzesniewski, & Dweck, 2007). In contrast, students with a growth mindset care about learning and employ more positive strategies to accomplish their goals, like an increase in effort (Blackwell, Trzesniewski, & Dweck, 2007). Additionally, a growth mindset may be associated with higher grades and better resilience, or propensity to bounce back if a student receives a poor grade (Grant & Dweck, 2003).

Regarding growth and development opportunities, ability in STEM is also associated with insufficient academic preparation. This insufficient academic preparation spans the entire United States, where students are allegedly not prepared for collegiate STEM classes because of their non-rigorous high school and elementary experiences (Perna et al., 2009; Lee, 2002; Yauch, 1999).

Even though women enter college with higher standardized test scores and earn higher grades in STEM college classes than men (Sonnert & Fox, 2012), research indicates that, when compared with their fellow male students, women have lower levels of confidence in their abilities to succeed, or lower levels of self-efficacy (Beyer, Rynes, & Haller, 2004; Brainard & Carlin, 1997; Buse, Bilimoria, & Perelli, 2013; Concannon & Barrow, 2010; MacPhee, Farro, & Canetto, 2013; Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012; Hathaway, Sharp, & Davis, 2001; Leslie, McClure, & Oaxaca, 1998; Wismath & Zhong, 2014). In addition, research also shows that women start college with lower self-perceptions about their performance in their STEM courses compared to their male peers, or self-concept (Espinosa, 2008; Sax, 1994a; Sax, 1994b). Decreases in self-efficacy and self-concept are associated with the imposter syndrome (Dahlvig, 2013). Through the imposter syndrome or phenomenon, people believe that they are imposters, "that they lack qualities of intelligence and competence, despite objective evidence to the contrary" (Simmons, 2016, p. 119). Those with imposter syndrome also overestimate the abilities of their peers, and their peers' efforts, while underestimating themselves (Parkman, 2016).

Lower levels of self-confidence in STEM can start as early as fifth or sixth grade (Meece & Jones, 1996; Pajares, 2005). In conjunction with this low self-confidence, engineering students begin their degree programs by taking "weed-out" courses, which are associated with the highest rate of failing grades or withdrawals and subsequent transfers to other, non-engineering academic disciplines (Suresh, 2006). Encountering these courses early is problematic because female undergraduates are often more sensitive to their grades and academic performance (Allen, 1999; Brainard, Laurich-McIntyre, & Carlin, 1995; Ost, 2010; Wentling & Camacho, 2008), placing a greater emphasis on grades as opposed to an emphasis on completing coursework as their male counterparts do (Concannon & Barrow, 2010).

Climate and Gendered Biases

Undergraduate women in engineering indicate the same intent to persist in their degrees as men (Concannon & Barrow, 2010), and engineering students overall persist in and complete their bachelor's degrees within six years of enrollment at a rate of 60.8% (U.S. Department of Education, 2005). This 60.8% graduation rate is compared to students in non-science and engineering degrees who, within the same time period, persist and complete their degree at a rate of only 55% (U.S. Department of Education, 2005). Even with higher than expected persistence rates, collegiate experiences that are recognized as factors contributing to the underrepresentation of women in STEM degrees include a lack of female role models, professors, or networking opportunities with other female scientists and engineers (Carrell, Page, & West, 2009; Chanderbhan-Forde, Heppner, & Borman, 2012; Chesler & Chesler, 2002; Drury, Siy, & Cheryan, 2011; Feeney & Bernal, 2010; Leslie, McClure, & Oaxaca, 1998; Sonnert, Fox, & Adkins, 2007). Both male and female STEM faculty and mentors are also biased towards male students over their female counterparts (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). In a related study, researchers even found that male faculty are more likely to ignore emails from prospective female graduate students than males (Milkman, Akinola, & Chugh, 2014). In sum, women plan to persist in their undergraduate engineering degrees at the same rate as their male counterparts, and women's persistence in STEM is positively affected by a positive, welcoming climate, which can be demonstrated through mentoring and networking opportunities both in and out of the classroom. Unfortunately, the extant literature indicates these positive, welcoming climates are infrequent.

In general, women are less likely to stay in academic majors where they are underrepresented because of sex discrimination and stereotype threat (Steele, James, & Barnett, 2002). Stereotype threat is when women fear confirming negative stereotypes about women (Beasley & Fischer, 2012; Steele & Aronson, 1995; Steele, James & Barnett, 2002; Van Loo & Rydell, 2014) to the extent that their anxiety or discomfort may actually do so

(Spencer, Steel, & Quinn, 1999). For example, as a result of stereotype threat, women may perform negatively, especially during exams (Inzlicht & Ben-Zeev, 2000; Steele & Aronson, 1995), and/or be less likely to pursue a STEM career post-graduation (Deemer, Thoman, Chase, & Smith, 2014). Additionally, stereotype threat is often present when women are outnumbered by men in their classes (Inzlicht & Ben-Zeev, 2000), contributing to a “chilly” climate (Allen, 1999; Blickenstaff, 2005; Goldman, 2012).

One of the greatest barriers to STEM participation is the systematic implicit bias against women in STEM (Carnes et al., 2012; Farrell & McHugh, 2017), such as the propensity to attribute women’s success in STEM to luck as opposed to skill (Williams, Phillips, & Hall, 2014). Farrell and McHugh (2017) find that implicit STEM bias is gendered wherein both male and female students have a pro-male-STEM bias but that only female students also have a statistically significant pro-female-STEM bias. This means both women and men believe men have a role in STEM, but women are more likely to believe women also have a role in STEM. This is further convoluted by gender roles wherein women engineers who act highly feminine are seen as incompetent in contrast to unfeminine female engineers (Powell, Bagilhole, & Dainty, 2009; Williams, Phillips, & Hall, 2014). In this regard, Powell, Bagilhole, and Dainty (2009) suggest that women can be their own worst enemies by acting like men to fit in and gain male acceptance (i.e., “acting like one of the boys, accepting gender discrimination, achieving a reputation, seeing more advantages than disadvantages, and adopting an anti-woman approach” (p. 425)).

Explicit biases where women experience sexual harassment and assault are also present. According to the U.S. Department of Education Office of Civil Rights (OCR), "Sexual harassment is unwelcome conduct of a sexual nature. It includes unwelcome sexual advances, requests for sexual favors, and other verbal, nonverbal, or physical conduct of a sexual nature" (Ali, 2011, p. 3). Per the dear colleague letter, "when a student sexually harasses another student, the harassing conduct creates a hostile environment if the conduct is sufficiently serious that it interferes with or limits a student's ability to participate in or benefit from the school's program" (Ali, 2011, p. 3). Unfortunately, sexual assault is prevalent on college campuses (Fedina, Holmes & Backes, 2016). In her dissertation on college sexual assault of undergraduate women in the digital media era, Andar (2014) reported that 66.1% (n=154) of her participants had been sexually harassed, 47.2% (n=110) had felt violated during a sexual experience, and 24.9% (n=58) had been stalked. These issues affect all persons on college campuses and women in engineering are not the only victims of sexual harassment or assault.

Compounded with biases against women, a "chilly" climate is reinforced by the language surrounding STEM courses (Mansfield, Welton, and Grogan, 2014; Parson, 2016). Women's persistence is negatively affected by male-centric science pedagogies where curriculums do not appeal to women because they do not demonstrate opportunities to help others (Blickenstaff, 2005; Lee, 2002). Diekman et al. (2011) illustrate this through the goal congruity perspective where, "women in particular favor communal goals, including working with or helping others, and STEM careers especially are thought not to fulfill these communal goals" (p. 902), to the extent that, due to this disconnect, or goal affordance stereotype ("beliefs about whether activities will facilitate the attainment of certain goals" (p. 905)), women do not pursue or persist in STEM fields. Nevertheless, some debate exists as to whether or not communal goals like sustainability and social justice have a role in engineering largely because social injustice and unsustainability often stems from engineering efforts (Brauer, 2012; Schneider, 2010). Meaning, in an effort to solve social justice and sustainability problems, engineers, through their approach, may create more problems, so efforts to introduce social justice into engineering should be taken with care.

Research Design

The purpose of this study is to better understand the experiences of undergraduate women graduating with degrees in engineering from a Southern, top-tier research, Predominately White Institution (PWI). To understand the experiences of women in engineering, a qualitative research design is most appropriate. Qualitative research affords iterative designs that generate nuanced data, allowing the researcher to meet participants where they are in their own contexts (Namey & Trotter, 2014). Instead of focusing on the perspective of the researcher, qualitative research is interested in self-interpretation, reflection, and meaning making of experiences by participants (Merriam & Tisdell, 2015). In this way, qualitative research can be open-ended, not manipulative, looking at the whole phenomenon, and assuming that each individual is unique (Patton, 1990). These are all factors that will benefit the exploration of the experiences of women in engineering, a population that, as previous literature demonstrates, needs affordances for participant-level variability, especially in regard to discipline, race, and ethnicity. Narratives are also important to feminist inquiries where,

> many feminist theorists have asserted that women's identity as a distinct and specific social group begins with their "lived experiences" as a woman – being whose lives, rights, opportunities, pleasures, and responsibilities are often directed by the value their cultures give to their perceived gender as distinct from that of men (McCann & Kim, 2017, p. 25).

In this way, a woman's "lived experiences," which are shaped by society, inform her identity.

In this study, narrative inquiry provides an opportunity to honor the unique storied experiences of undergraduate women in engineering. Clandinin (2014) defines narrative inquiry as, "an approach to the study of human lives conceived as a way of honoring lived experience as a source of important knowledge and understanding" (p. 17). This gives homage to the feminist standpoint of the female engineering students that have an inherently different experience than their male counterparts. A narrative approach will empower participants to define their own salient themes or what themes are most important to them (Elliott, 2012). Narrative research emphasizes turning points, such as those moments when a woman chooses to participate or recommit to an engineering degree or career, and it places events in sequence (Elliott, 2012), which will help define a trajectory. A narrative research design can also focus on a specific place or situation like an engineering degree at a particular college or university such as North Carolina State University (NC State) (Creswell, 2013). This location and empowerment, or sense of truth, form the women's standpoints.

Participants and Site Selection

The site for this study, NC State, is a predominantly White, land grant, tier-one research institution in the South. Due to its status as a land grant institution, per its mission, this institution has a wide range of agriculture, science, and engineering programs (Marcus & Geiger, 2015).

In this study, purposeful sampling was used (Merriam & Tisdell, 2015), and criterion for participation included: self-identification as a woman, full-time enrollment in an engineering degree program at NC State, enrollment at NC State for at least three consecutive years, at least a 2.0 GPA, and senior status with the intention to graduate within the current academic year. Participants were recruited through engineering support programs including the Goodnight Scholars Program, a scholarship program for middle-income students interested in pursuing a STEM degree, Women in Science and Engineering (WISE), a living-learning village for women in STEM, the Engineering Village, a co-ed living-learning village for freshman interested in engineering, Minority Engineering Programs, a resource for African-American, Native American and Hispanic students who want to become engineers or computer scientists, and TRIO Student Support Services STEM, a college retention and degree completion program for under-resourced undergraduate students pursuing degrees in STEM.

Gatekeepers for these programs emailed eligible participants. The email invitation included participation criterion, incentive information ($10 Starbucks gift card), and instructions for contacting the researcher to volunteer as a participant. In addition to participant recruitment via email, gatekeepers also posted fliers to invite participation in this study.

To confirm eligibility, at the beginning of the interview, participants presented their unofficial transcripts, which indicated their enrollment in an engineering major, their academic statuses, GPAs, and any transfer credits. These methods yielded 11 participants listed in Table1.1. After being accepted into the college of engineering, and being accepted into their majors, two of the participants switched from nuclear engineering and mechanical engineering respectively, but the final major breakdown of participants includes: aerospace engineering, biomedical engineering, chemical engineering, computer science, industrial engineering, mechanical engineering, and nuclear engineering. One of the participants identified as African American, one identified as two or more races, one identified as "a type of brown not captured by the U.S. census," and eight identified as White. All the participants were 21 to 24 years of age.

Table 1.1

Participant Information

Pseudonym	**Engineering Major**
Daphne	Aerospace Engineering
Becky	Biomedical Engineering
Callie	Chemical Engineering
Shauna	Chemical Engineering
Stephany	Chemical Engineering
Dawn	Computer Science
Allison	Industrial Engineering
Katie	Industrial Engineering
Tara	Industrial Engineering
Karen	Mechanical Engineering
Ashley	Nuclear Engineering

Data Collection

Forsey (2012) advises that interviews are the most efficient way to get full, rich data quickly. Study participants were interviewed by the researcher in a private study room in the library for approximately one hour. Terrell (2016) suggests that through narrative studies we seek to complete the following statement: “If I could discover the meaning of one person’s lived experience, I would ask the person ______” (p. 155). This question elicits the imagery of a magazine feature, where the participants tell their stories in the light of which they want to be seen. To accomplish this, the first interview centered on the question: “In twenty years, imagine you are featured in a magazine about successful women. What would your article say? What are your history and your future especially in regard to engineering?” A full list of interview prompts used to elicit the stories of participants is included in Appendix B.

Data Analysis

The interview prompts sought the storied experiences of participants. These “ordinary lived experiences” are the beginning and end of narrative inquiry (Clandinin, 2014). Through narrative analysis, this study “uses [the] stories people tell, analyzing them in various ways, to understand the meaning of the experiences as revealed in the story” (Merriam & Tisdell, 2015, p. 24). These various analyses took the form of different coding methods. The interviews from this study were audio-recorded and transcribed. Then these interview transcriptions, field notes, and memos were de-identified using pseudonyms and coded.

Coding Methods. The materials from the first interviews underwent eclectic coding which consists of a combination of first cycle coding methods (Saldaña, 2012), including: process coding that uses gerunds to signal action in data (Charmaz, 2002), in vivo coding that uses participants’ own words, narrative coding that applies literary elements to tell stories (Saldaña, 2012), and values coding where codes reflect, “values, attitudes, and beliefs, representing his or her perspectives or worldview” (Saldaña, 2012, p. 110). Next, the materials were reviewed again using second cycle coding, which include axial coding methods to remove redundant and less important codes (Saldaña, 2012). Lastly, the materials were reviewed a third time using pattern coding methods to look for salient themes (Saldaña, 2012).

Trustworthiness

Miles, Huberman, and Saldaña (2013) and Merriam (2002) detail many methods to safeguard validity and reliability in qualitative research. This study utilized these same practices. First, with the small number of participants in a narrative study, care should be given to not over generalize or imply that findings are representative of an entire population. Second, to protect against researcher effects, the researcher details her positionality, and questions any interpretations based on this positionality. Further, as is the nature of narrative research, researchers can become narrators themselves in how they code and shape their participant data (Elliott, 2012). As a result of these potential biases, the researcher needed to be cognizant of allowing participants to speak for themselves, to not superimpose meaning from other research findings or general assumptions from the field, to ask for participant clarification when necessary, and to challenge existing social assumptions.

The researcher can also protect against researcher effects through data quality checks. These data quality checks can take the form of triangulation through deep data collection to reach saturation, and conducting member checks by getting feedback from participants. In this study, member checks were sent to participants via an online Qualtrics survey (see Appendix C) where participants were provided with the general themes from the entire study and asked to provide short essay responses about their reactions, whether the themes represent their experiences, and if not, then what is missing. Participants were invited to partake in the data quality checks by email and reminded weekly for up to three weeks, or until a response was received. Ten out of elven participants responded to the survey and confirmed the study's themes.

Third, in relation to safeguarding reliability and validity in qualitative research, this research study should be auditable. Miles, Huberman, and Saldaña (2013) point out that this auditability comes from having clear research design. Additionally, in achieving a clear design, Merriam (2002) and Lincoln and Guba (1985) stress the importance of process notes or memos. The researcher for this study subscribed to these recommendations and employed frequent memoing about participants and design and analytical decisions. Lastly, to safeguard reliability and validity, attention should be paid to authenticity and fit where rich, thick descriptions are important and data provide context and is connected to theory.

In regard to this study, I, the researcher, am a White female that does not have an academic background in engineering. Despite not studying engineering, I have worked professionally with engineering students for almost a decade, and, during my doctoral student tenure, I have participated in numerous studies addressing issues affecting women in STEM.

Participant Stories

From the participants' stories about their experiences in engineering, representing their standpoint as a female engineering student at NC State, four themes emerge. The women told stories about sexism, self-doubt and feeling like an imposter, enacting a growth mindset, and using engineering to do good.

Sexism in Engineering

The women all had experiences with sexism, mostly in the form of implicit bias, where they were treated like they did not belong. More concerning, some participants also told stories of explicit bias, or sexual harassment.

I'm the only girl. Every participant spoke about being the only girl in their classes or their groups, especially in the early, pre-major engineering courses. In these environments, every participant also spoke about having their opinions discredited because of their gender. Callie articulated this best: "I think in engineering that's the biggest thing, just realizing that you're probably going to be the only female and there's a possibility that they might not respect what you have to say." Allison, like many of her peers, also felt discredited during an internship or a co-op experience:

> I think you definitely, kind of get a little bit of the, the stereotype and like "oh, you're a girl, and especially a girl with blonde hair, right? You probably don't know what you're talking about." So, things like that. I would have guys that sit next to me that would discuss homework, and they would just discuss it with themselves. They're like "oh, she's probably clueless." So, you do find that a little bit, I think you find that in the real world, too, right? When I worked at [Manufacturing Plant], I think I really, had to earn my place by actually, convincing my managers that I do know what I'm talking about. It was primarily all men, and especially… when you're working with

> the operators that work in the assembly lines, a lot of the time they're like " she probably doesn't know what she's talking about," right?... I think, in general… it might be a stereotype, but it's a thing, that I think, has worked to my advantage. Just telling people you're in engineering, right? I think they look at you totally differently. Like, when I'm first getting to know people and they're like "oh, what are you in? You're, you're in like marketing or something, right?" And then you're like "well, no, you're in engineering." It's funny to watch the expression change. They're like "oh, I would have never guessed that you're in engineering. I think, the title alone kind of makes people look at you a little bit differently.

Allison considered being underestimated an advantage, but in Industrial Engineering, feeling underestimated did not continue throughout her degree. This is not the same experience for women in fields that are more male dominated. For example, Ashley, in Nuclear Engineering still experienced bias in her senior design course:

> I think sometimes people just don't want to listen to girls. I remember also in my Physics class, this is what got me in my problem session, I was with a group that was all guys and they just never listened to me. So, I never got the experience to write on the board, or do the physics problems with them, I was just there taking up space and air. When things like that happen, I feel like... you don't want to say it's an impediment, but you know that had your name been Scott or Marcus, you probably wouldn't be not listened to. But now people listen in your major, because… Sometimes in senior design I get the "yeah, yeah, yeah, yeah", but then ten minutes

> later they realize I'm right. Also in homework groups sometimes, but I think it's also because I'm just "you don't want to listen to me, that's fine, but I'm going to do my homework because I know I'm right, come back to me in ten minutes when you know I'm right". I don't think it's played a role other than showing other girls that they can do it, especially in nuke, because so many people have misconceptions about our major.

Ashely did not feel able to participate in her Physics class because of her male groupmates. At the end of the degree, many of the women thought that they had earned their peers respect because they were still there, Ashely started to indicate this but then said that she still feels discredited for her gender. Stephany indicated that some of the faculty are aware of this problem:

> Well, I think it'd be good to have someone in the engineering curriculum initiate a discussion about how people should behave toward each other. I realize, that's kind of a low-level discussion to have if you're talking about engineering as a very intellectually astute discipline, but it's kind of necessary at some level. I've heard one of the engineering advisors talk about, "Women, don't feel that you need to be confined to a secretarial role in a group." She's really talking about that kind of experience of all the guys want to be hogs, and they don't want the women to do anything, really, in the group. I've heard that come out of her mouth, but I don't think that everyone has heard that come out of her mouth. I think that seeing more faculty

> members like that initiate discussions on certain topics, presumably, not just gender dynamics, but also racial and cultural things.

The crux of this statement is that women's experiences in engineering can be gendered wherein they may often be reduced to "secretarial role[s]." Even if the faculty are aware of this issue, again, all of the women interviewed had this experience.

Tara is also an industrial engineering student, however she started off in nuclear engineering. She told a different story about gender bias:

> I think I've been really fortunate, in that it hasn't been a big deal. I think that there has been plenty of cases where there's snide comments or ... Maybe sometimes I've been the cute girl that the TA's like, "Sure, I'll stay extra after class to help you extra," or something like that. I know my very first ... I was going to a guest lecture for nuclear. This was my freshman year, and I was so excited. I had just met one guy walking in, so I was, I sat down and was talking to him. We were the first two there. So, the guest lecturer walks in. I guess there was a student panel going on right after, and so he assumed that the guy was on the panel, and he told me it was so nice of me to come and support my boyfriend. I was like, "Hey, I don't know this guy. I just met him, and also, I'm here to learn too." That was right off the bat on campus. That's something. The nuclear industry is really full of old white guys. It really is. There's been small cases like that.

To Tara, these instances are not a big deal. A handful of the participants indicated that they never experienced sexism or were made to feel that their gender was a disadvantage but then they all went on to tell stories like Tara. The other participants more easily labeled sexism. Here, Karen described what it is like in some of her Mechanical Engineering courses:

> We're divided into groups of five and I'm the only girl and, … now we're in the machine shop actually building, so it's definitely a change of dynamic from sitting in class with all the guys versus hearing them do their shop talk or whatever. It can be kind of intimidating because all of the TAs are guys, also, and when you ask for help using a machine, I feel like it's like they're judging me because I don't know how to use it because I've never- I feel like guys are brought up using power tools and stuff and I've never used anything like that, so I'm trying to make sure I don't cut my arm off or anything and they're just giving me a hard time… I think they're sort of like that with everyone. We have to check out certain tools from this closet and there's supposed to be someone sitting in the closet at all times, but in one particular case, I was with this other guy in my group. We went over to the closet and no one was there, so we went over to the table where all of the TAs were sitting and he was just like, "Can someone- I need to check out a grinder. Can someone help me," and they all just stared at him. I know they do it to everyone, but I don't know if it affects me more just because I am not confident in myself when I'm down there already. I don't know.

Karen indicated that she feels at a disadvantage because she may not have the same experience or level of familiarity with power tools as the male students, and then, as a result of this inexperience, she felt judged.

She's so fine. Beyond being underestimated, discredited, or feeling like women cannot participate, some of the women interviewed also described instances of sexual harassment. For Dawn, this harassment came during a co-op:

> When I was working at this company [Computer Programming Place], there was my cubical mate and he was supposed to be my mentor. He helped me get my environment set up and helped me learn about the project and all of that but then there was this other guy who turned out to be sort of my unofficial mentor and he was the one who was actually giving me projects because the guy who hired me didn't have the time. He ended up getting really creepy, really touchy. I actually ended up having to report him to HR. There was a lot in there. That, I think, probably the only time I felt like ... Kind of wish I had been a guy instead of a girl in this moment… They were awesome about it. My manager apologized profusely: "I can't believe your mentor would do this especially when he's like in a mentorship position. We've talked about this, they have sexual harassment training and stuff." For the last two weeks that I was there, they made him work at home so I could work in a safer space.

When Dawn reported the unwanted advances of her coworker, the company responded proactively. Callie also described unwanted attention during her co-op when asked about her least favorite experience during her degree:

> I would say my first co-op with [Manufacturing Plant], which is one of the reasons I didn't go back. I don't know if it was the work that I didn't enjoy or just the work environment. Being a female, I had a couple of my bosses that I felt were trying to hit

> on me. I told my co-op advisor that's why I didn't feel comfortable going back. She sympathized, but then she was also like, "Well, that's going to happen in the industry." I was like, "Well, I understand that that's going to happen" but I wasn't okay with it. I just didn't feel comfortable going back.

Unfortunately, when Callie mentioned her experience, her advisor told her “that’s going to happen in industry.” Regardless of the fact that this type of behavior is not appropriate, Dawn was supported and shown that this type of behavior should not happen, whereas Callie received the message that this is the way of things.

A few women also detailed sexual harassment on campus. Stephany told a story about her lab partner telling her that she should smile more and that she would be more attractive if she smiled. She also said this:

> Oh, the other thing that guys do in group, is they like to blatantly check out women that are, like, say we're in the library, they would check out every single girl who's passing by, in front of all their female group mates. However many there may be, and they really have no clue how objectifying people in front of others makes them feel...Oh, they say things. They're like, "Oh, she's, like-" I don't know, I don't know what they would say exactly, but they'll, like, name a body part, and then be like, "Oh, she's so fine," or whatever. It's just, like, yeah, that's pretty demeaning.

The sexual comments of Stephany’s group mates made her feel uncomfortable. Comments like these, in addition to the unwanted attention detailed by Dawn and Callie, and the feelings of underestimation or being discredited shared by all of the interviewees, all disempower women and make them feel like they are not welcome in engineering.

Imposters

Women also disempower themselves by doubting their own abilities and performance. The participants discussed how they sometimes thought they were imposters or that they could not hack it in their engineering major. Dawn told this story about feeling like an imposter:

> I remember being in Java two my first time because I failed it and taking the courses and doing the assignments. The problem is, they would give you, here's one tutorial, here's two tutorials, here's three tutorials. All right, you're all ready for the projects. By that time, [the] drop date has passed and you're like, I can do this. This is easy. Then, the first assignment hits you and you get a 16 on it. The second one and the third one, they were all just terrible. I remember emailing my professor on the third one and being like, I'm not passing this class. There's no way I can. I'm not going to put the effort into this assignment. Don't get me a partner because they'll get screwed. I went to my advisor because [Professor] was like, "I'm kind of worried about you. You should probably go talk to your advisor, let me know what's up". I went and talked to [Advisor]. I'm trying not to break down. She just takes one look at me and was just like, let's go get muffin from [Coffee Shop]. We went and got a muffin, talked about our artificial intelligence, talked about what got me interested in computer science in the first place. I confided in her that I felt like an imposter in

> computer science. I wasn't intelligent enough to be there, I was just riding off of everybody's coattails, et cetera. She was like, everyone has that feeling. Everybody in computer science feels like that. I didn't believe her until a month ago when I talked to one of the directors for computer science, he was like, you have no idea how many students we get that say the same things. A lot of my friends confirm that too. I feel a lot better about it but it was terrible. I felt like I wasn't smart enough to be in computer science... A big part of the reason I felt like I wasn't smart enough to be in computer science was because I had a lot of help from everybody. Java one was super easy. You didn't need to do anything for that. Java two, my second time, I had a lot of help. One of my partners was fantastic and he pulled his weight and he taught me things and I helped him with things that I could understand. I felt like I didn't do the project. I know I did, logically, I did but I didn't feel like I did it because I didn't do all of it. So, in game engines, when I did all of those, all by myself, no help. I went and talked to the professor about algorithms that I was wanted to implement, stuff like that. After I did that and I submitted the assignments and I got 100's on all of them I just felt like, maybe this is where I need to be. I'm really glad I took the games concentration because that restored my faith in myself.

Dawn felt like she could not hack it and doubted her ability, in spite of her advisor telling her that everyone feels that way. She was only able to reverse this mindset with further confirmation that her peers also felt the same way and by proving to herself that she did belong. Callie also questioned her ability:

> It was like, "I'm an engineer and chemistry is supposed to be easy. I'm supposed to know this material." I think I just didn't realize that I'm taking chemistry classes along with my engineering classes, which I've kind of put my engineering classes as a priority versus there's other people who are in the chemistry and organic who are only taking sciences. They have more time to dedicate to the science classes. The science class is supposed to be low on my priority because it's engineering. I think it was just one of those moments where I was like, "Man, what am I doing wrong? I'm a chemical engineer, I should know how to do this." It just required a lot more time and effort that I think I had at the time. I tried to do 18 credit hours and it was just unrealistic. It was sophomore year so I think I went from freshman year being easy
>
> and I was able to do the load, so I tried to put more on my plate but it didn't work out

The class that gave Callie trouble was not an engineering course but it is still required for her engineering major. Regardless, these experiences illustrated by Dawn and Callie show that at times many of the women interviewed felt like they were imposters.

For Shauna, and other women, feelings of self-doubt also permeate into considering whether or not they should even be in the major:

> Sometimes I wonder if I only got into the chemical engineering program because I'm a woman and they wanted to fill those minority spaces, just because I was the valedictorian that might have gotten me in, but my salutatorian was a male and he didn't even get into the engineering program. It's like we were so close in GPA and in extra-curriculars but I got in and he didn't even get into the engineering college. Was

> it because I was a woman or was it because I had a better GPA and maybe I did a couple extra activities, so sometimes I think about that.

Given the accolades that Shauna lists, she is well accomplished and worthy of being in the program, but because of her gender, she doubted herself.

Overcoming Gut Checks (Enacting a growth mindset)

When responding to the biases and self-doubt that they face during their interviews, the engineering women detailed a growth mindset, or a propensity to bounce back, work hard, and overcome adversity. Tara associated this mindset with being a woman in engineering:

> I think the women in engineering are way more determined than the guys are. I think a lot of guys kind of just end up in engineering. They're like, "Oh, my mom said was good at math, so I applied to engineering school." Or, "My guidance counselor was like, 'Yeah, you're good at science, so go into engineering.'" But I think the girls that are here, from what I've noticed ... We've wanted it. We've worked at it since high school. We very specifically did summer camp, or we took the extra classes in high school or something, and continued that through college. Almost all of the leadership boards I've been on for engineering clubs at [NC] State have been majority women. Which is really exciting, right? Because I think we're just so set on being an engineer, where it's like, "We didn't haphazardly just pick this." Right? It's like, it was something that we very much chose.

To Tara, the women are not only in engineering because they are good at math and science, they are in engineering because they are genuinely interested in it and they have worked hard to be in their degree programs. The women have had to put forth lots of effort and will continue to do so. Daphne also labeled the spirit of being a woman in engineering when speaking about meeting an alumnus of NC State, Christina Koch, a United States of America Astronaut:

> Because she kind of is of the same mindset that I am, or I guess I'm of the same mindset that she is that as long as you follow what you're passionate about it's going to work out. She knew she wanted to be an astronaut, but she just kept doing things that she was passionate about. She kept going alpine rock climbing, and she kept accepting jobs in Antarctica, and stranding herself there for a year with no contact with anyone else because she was passionate about it, and because she wanted to do it. Eventually all of those things really stood out to NASA, and they said, "Whoa, you'd make a great astronaut." Just meeting her and really getting the affirmation, that feels really good. Felt really good. Past tense.

To Daphne, being passionate about something that you want to do enables you to work hard and achieve your dreams.

As detailed in the previous section, participants also spoke about difficult coursework and how that may have made them doubt themselves. Since they are all still in their engineering majors and about to graduate, they have also overcome those challenges. Ashley described one such opportunity:

I don't tell a lot of people but I actually failed Physics 1 when I first got here. That was one of my worst moments in engineering, as well as one of my best, because had it not shown me how I need to go about my next three years, I would have not flunked there, but somewhere where it was a bit more important. So, for nuke we're cyclical, if you fail a class, you have to wait a whole year to take it again… I would say just doubting yourself, because the doubt is always there. You know, I just didn't know how to study for it, and I think off the bat I was dejected to study for it because I didn't get one or two of the first topics, so okay I was kind of studying. And then when you go to the professors, sometimes... the professors are usually great when you go help, but I think I was just so not getting it, that from there it just made me less and less want to... which I think you hear a lot, kids even younger ages they get dejected or they get told they're wrong, or they don't know and then… It spirals. That's what happened, it spiraled from there because I was so... I tried really hard. But when I took it again and I got the first... man much better. Because I took it in high school, but the high school I went to was kind of "lets graduate and not get you pregnant". And I hate to put it that way, but that's the reality of what it was. It's a good day when people are going to community college there. I don't think they were exactly... not keen, but I wasn't a priority to make sure I was ready for an institution like this. I got with a friend that I knew was very good at this stuff, so I would sit down and work through the problems and immediately when I didn't understand something, I worked it out now I'm taking it to the professor. I wasn't going to wait and try again, there

> was an immediate turn... every time there was a new topic, go practice it, do the homework, and then immediately bring it to him. And then when it's time to study for an exam, you go through every single topic and you go through it with that friend, and you make sure you can answer the questions that you haven't... you know how you might have already memorized the homework answer, so you're like "oh I know how to do this", but I show you the same problem but completely different numbers and you're like "I don't know how to do this". So I made sure I knew how to do that… Nuke I think is more a gut-check more than anything. It was just a lot of gut-checks and I think getting through that... Support of your friends is good, but you have to believe in yourself. Because I just had to buckle down and say "okay, you have to do this and if you get a zero on it, that's fine, but you at least need to turn in something". I ended up getting at 98, so yeah.

As detailed in her interview Ashley did not have an easy transition from high school to college. She's had to work really hard to get to where she is in life. Her early life might not resonate with all of the interviewees, but like Ashley, a handful of the participants mentioned failing a class and their approach to re-taking it so that they could learn what they needed to learn and pass the next time. The women had to enact a growth mindset to make it to the ends of their degree programs.

Women Engineer a Better World

The women also told stories about engineering and social justice both in the way that they would like to recruit more women into engineering, and in the way that they would like to use engineering for communal goals, or to do good. In their interviews, the women were asked about their favorite engineering experiences and the majority of participants associated moments of helping others as the most enjoyable experiences of their degrees.

Girls who step-up. In regard to increasing women's representation in engineering, when Shauna was asked to describe what she would like a future article about her engineering career to say, Shauna explained:

> I'd really love it to say that I was a person who really tried to encourage more in younger women to get into STEM fields and really just saying that you can really have it all. You don't have to give up your personal life over your engineering career. You can find ways to make both of those happen.

Shauna wants to disapprove stereotypes about women in STEM that prevent young women from pursuing a career in engineering.

A majority of the participants spoke about recruiting more women to engineering through their work with the engineering ambassador program, a campus group that helps recruit students to the College of Engineering at NC State. Ashley, like many other participants, described how these recruitment efforts made her feel:

> I'm also an engineering ambassador for NC State, so a lot of times during info sessions, we get all kinds of kids - some people that are like "I already know what I'm doing, my brother goes here, I got this all figured out, thanks for talking to me but I don't care." Some people that are like "what is the common app, how do I submit scores?", all that range. So, when you talk to someone and see the spark in their eyes,

> or see the hope... the people we present as examples in those power points are up here, Walter Reed research, crazy stuff. Some kids are like "how am I ever going to".... So just reassuring them, those are two of the happiest I've ever been in engineering.

For Ashley, helping students see that they could pursue engineering was meaningful for her. Katie also made a point to identify that it is mostly female students that step-up and assume this role:

> ...I've actually noticed that the females in engineering are a lot more involved than males. I'm on the executive board for Alpha Pi Mu, which is the industrial engineering honor society, and it's all girls. We're all girls. Also, with engineering ambassadors, I mean, there are boys and girls, I think there's maybe more boys than girls, but whenever it's time to make ... within engineering ambassadors we have little leadership teams who are in charge of planning...Normally, it's all girls who step up for [the lead TA] job, and a lot of times we will have info sessions for the college of engineering to prospective students and their parents, and we'll have to make a joke like, you would think, because it will normally all be girls, and they'll just have to say there are boys who actually go to here.

Per Katie's observation, the female students are more involved on campus, especially in efforts to recruit more students to engineering. Being involved and helping other students and potential students is important to the women interviewed.

Meaningful Coursework and Careers. Some of the participants also had particularly meaningful coursework or research that they described as their most enjoyable in engineering. This coursework enables the women to contribute to communal goals, or betterment of society. For example, Karen was involved in research regarding rehabilitation of tendons:

> ...What I would do is take these tendon samples from a pig leg, so I dissected pig legs, which I didn't think I would enjoy, but it was not too bad. I would take a cross-section of the tendon and stretch it on a tester that we had and then record the force and calculate the stress and the strain on the part. Investigating that was to see how the tendon reacts to being pulled both ways because most people testing tendons just pull it along the long axis of the tendon. My professor was hoping in that that we could figure out maybe a new rehabilitation method for people who have tendinitis or who have injured their tendons in sports injuries and stuff. We found out that, in one particular case, stretching it both ways would protect the tendon from shearing, so she was- that confirmed her theory and then she was going to have one of the grad students make up the model for it and model that digitally I guess.

This research afforded Karen an opportunity to engage with her professor and other students to potentially improve the physical well-being of others through rehabilitation improvements. Becky had a similar experience in a class:

> ...She was a professor in the process of adopting a child and she had a cleft palate facial deformation… so she took the material that we were learning in terms of what

> material would you select to design a catheter or a stand and relate them back to her daughter and be like this is my child and the situation now, what are you going to do for her? It just made it a little bit more relatable and you could see the actual application versus writing down a chemical equation and drawing a diagram, leaving it at that.

For Becky, her professor made a meaningful connection to something going on in her life. In these examples, both Becky and Karen were working with female faculty members to address issues that negatively impact the lives of others.

Beyond meaningful coursework, some participants also spoke about wanting meaningful outcomes from their engineering degrees. For Dawn, her computer science degree could help propel her into a career in cyber security to help defend the United States from threats of terrorism. However, for Daphne, she found her degree in conflict with helping others:

> At least right now there's definitely the culture climate of the U.S. is the savior of the world, and we are the "good guys" and the middle east is the "bad guys" because of whatever turmoil is going on there. The result is that they don't want us to succeed. Through the aerospace industry whether it's an entire research project they're working on. Whether it's an entire government contract you're working on. There's some sort of feeling that whatever you develop is going to go to something that in one way might harm another person. Since the Department of Defense does get so much funding, and whether you work for Sandia National Labs or Boeing or Lockheed or

> GE, your work eventually will probably go towards something in the Department of Defense, and that Department of Defense really seems focused around, pardon my French, but bombing brown children. That doesn't sit well with me. It doesn't make me feel good. It doesn't make me feel like I want to be a part of it. There's all the cool things like going to space, and then there's the big overarching theme of we are in some sort of interaction with the middle east that isn't absolutely ideal. A lot of our "solutions" are to just weaponize our army or our military, and just go for it. That doesn't sit well with me at all. My friend that I had mentioned earlier who decided that he wanted to go to law school, he was like, "I don't want to bomb brown children. I want to go to law school so I can work on policy, so I can make things better." There's some part of me, and maybe it's the whole I'm from the U.S., and I feel like I need to be the champion of the world sort of thing, but I definitely want to be able to bring affordable energy to people. Because the whole fact that we're so dependent on OPEC to set oil prices, there's people that just can't meet that demand. That's unfair, and they shouldn't have to live without just because of some situation. In my heart of hearts, I want to be able to be like, "Yeah, here's wind energy, and it's affordable, and it's accessible to everyone, and there's policies that are in place so that you don't get a perceived punishment for not using fossil fuels." It's beneficial to use clean energy instead. I just want to be able to bring that to the world.

To address the conflict of her aerospace engineering degree, Daphne wanted to use her degree in a non-traditional way. Instead of working on airplanes, or rockets, Daphne wanted to work on wind turbines to increase affordable, clean energy. Regardless of the outcome, Daphne and Dawn, the future cyber security specialist, wanted to use their degrees to do good and feel warm and mushy inside.

What do these stories tell us? Implications for what we should do.

The stories of the participants demonstrate some of the communal experiences, or feminist standpoints, of this group of women in engineering at NC State. They also highlight many implications for practice or opportunities to improve the experiences of women in engineering. These opportunities include strategies for colleges of engineering and for faculty to rebrand and/or reconfigure learning in ways that better support women. The opportunities mirror the four themes of the previous section and they include: they might not respect what you have to say, should I be in engineering, determination and hard work, and engineering a better world.

They Might Not Respect What You Have to Say

All the participants told stories illustrating implicit bias on the part of their male classmates. In group work, the women were the only female in their groups and their opinions, suggestions, and work were often discredited. Women often must “prove it again” or provide more evidence of competence than men in order to be seen as equally competent (Foschi, 2000). The specific engineering major of the participants affected whether this discrimination continued beyond their early, introductory engineering coursework. For the participants in the fields with a higher proportion of women (although still less than men), like biomedical engineering, chemical engineering, and industrial engineering, the bias seemed to have discontinued or lessened by the end of the women's degrees (NSF, 2015). Whereas, the women in aerospace engineering, mechanical engineering, nuclear engineering, and computer science still experience sexist behavior from their group mates towards the end of their degrees.

To a lesser extent, some participants also experienced bias from professors or teaching assistants. Institutions implement bias literacy workshops to help faculty mitigate bias and promote gender equity (Carnes et al., 2012); however, studies like that of Jackson, Hillard and Schnieder (2013) suggest that even with training, male faculty endorse women stereotypes more frequently. While the participants indicated their faculty and graduate students were supportive, they then told stories indicating the opposite (i.e., where it was assumed that they were attending a panel to support a boyfriend or the felt that they were shamed for not knowing how to use power tools). The lack of acknowledgment about sexist behavior is troubling, in ability to label something as "sexist" but, further, to recognize certain behaviors are inappropriate, harmful, and wrong. According to a feminist standpoint theorist,

> Sometimes the ruling ideology succeeds in duping [oppressed groups] into partial denial of their pain or into accepting it temporarily, but the pervasiveness, intensity, and relentlessness of their suffering constantly push[es] oppressed groups toward a realization that something is wrong with prevailing social order (Jagger, 2004, p. 56)

By talking about these experiences, and learning that other women have similar experiences, the participants start to realize that something is wrong. Just because something is the statusquo does not necessarily make it right. Part of understanding what behaviors are unacceptable is labeling them. Universities have a responsibility to define unacceptable behaviors and, more specifically, what is "sexism."

To a lesser extent, some participants also told stories about explicit bias, sexual harassment or assault. According to NC State's Equal Opportunity and Nondiscrimination Policy, harassment is unwelcome conduct based on, amongst other things, sex or sexual orientation, so as to, "deny or limit a student's ability to participate in or benefit from NC State's programs or activities; or create an intimidating, threatening or abusive educational environment" (NC State University, 2013). While the stories of more blatant sexual harassment occurred during internships in settings of industry, the fact that these internships were university sponsored emphasizes the need for institutions of higher education to work to reverse biases against women, especially regarding their male students that will dominate the industry in the future. Again, labeling and defining unacceptable behaviors should happen at the university-level, but the university can also push these policies to their industry partners. That way, these industry partners understand what environment female students expect and deserve when they participate in a co-op or when they eventually graduate and enter the workforce. Additionally, more education around resources and policies needs to happen on all levels so that the undergraduate women know what behaviors are unacceptable and where they can report inappropriate behaviors. In return, industry and university members need to know how to handle and respond to such complaints so that unacceptable behaviors are discouraged instead of ignored.

The biases toward women in the professional world seem to be an extension of the climate in collegiate engineering programs. Stephany told a story about her group mates "girl watching" and how that made her feel. Quinn (2002) writes about this phenomenon:

> First, girl watching appears to function as a form of gendered play among men. This play is productive of masculine identities and premised on a studied lack of empathy with the feminine other. Second, men understand the targeted woman to be an object rather than a player in the game, and she is most often not the intended audience. This obfuscation of a woman's subjectivity, and men's refusal to consider the effects of their behavior, means men are likely to be confused when a woman complains. Thus, the production of masculinity though girl watching, and it is harassment.

Quinn (2002) is pointing to the confusion over male behavior as to whether or not "girl watching" is a form of sexual harassment. For Stephany, her group mates made her feel uncomfortable, which affected her experience and participation. Universities have a responsibility to better engage their male students to be better allies to their female counterparts, especially in regard to group work, and especially in these behaviors like "girl watching" and the implicit biases that are embedded in collegiate engineering settings. Ideally, male engineers would then take this training with them into the workforce.

In sum, Universities could enact a campaign around an idea that "engineering is challenging enough, don't make it harder." This campaign could define unacceptable behaviors towards women, and recruit faculty, staff, and student participants to pledge to enact better environments for women. Further, standards from this campaign, for example, “commentary about women’s bodies is not appropriate at any time,” could be included in course syllabi and posted in departmental spaces or on university websites and social media. Students should be held accountable for these standards and, when universities make partnerships with employers, they should be shared with them as well.

Should I be in engineering?

Gendered biases against women regarding their STEM abilities (see Carnes et al., 2012; Farrell & McHugh, 2017; Williams, Phillips, & Hall, 2014), also affects women’s self-concept, perceptions about their abilities compared to their peers, and self-efficacy, or confidence in their abilities. Decreased self-efficacy and self-concept are associated with feeling like an imposter as some of the students said themselves (Dahvlig, 2013). The women told stories questioning their abilities on multiple levels: about assignments, about classes, and about their majors overall—whether they could meet the requirements of their majors or if they should have even been accepted into their majors in the first place. The women also told stories about being intimidated because they did not know something.

When women do not think they belong in their engineering majors, they are apt to transfer, as three of the 11 participants in this study did, transferring from one engineering degree to another with more women. When someone, like a woman in engineering, feels like the only one and not a member of an insider group, she is more susceptible to social identity threat, stereotype threat, and lower levels of self-efficacy, and self-concept (Crocker, Karpinski, Quinn, & Chase, 2003; Dasgupta, 2011). To combat the imposter syndrome, Dasgupta (2011) writes about the stereotype inoculation model, “that shows how in-group members (experts and peers in high-achievement settings) function as ‘social vaccines’ who inoculate and strengthen fellow group members’ self-concept so that they become free to choose less traveled paths” (p. 232). Group work in early engineering classes might be a means to “inoculate” women against feeling like an imposter, but it is not working for the participants of this study.

In these introductory courses, faculty could do better to highlight the value of diverse opinions and perspectives within groups. This could be attempted through storytelling and describing instances where engineering teams without women faltered (see: Margolis & Fisher, 2003). Preventing bias could also be incorporated into student learning objectives. For example, Engineering 101, Introduction to Engineering and Problem Solving, could include the following learning objectives: students will be able to demonstrate the integration of diverse perspectives in problem solving efforts; or, students will be able to appraise the effect of engineering solutions on different types of people (race, ethnicity, gender, nationality, etc.).

Determination and Hard Work

To combat biases and feeling like an imposter, participants told stories demonstrating how they employed a growth mindset, a belief that they could develop their abilities as opposed to believing that one’s ability in math and science is fixed (Dweck, 1999). The women explained that they were more determined, worked harder, and were more involved than their male counterparts. They illustrated examples of strategies to overcome adversity, especially when failing an assignment or even a class. The women show that asking for help is not a bad thing and does not mean you are not smart. In light of this, the women in this study are very clearly the victors—in spite of the challenges that they faced, these women were a semester or two away from earning their degrees in engineering. An implication of this is that these behaviors should be encouraged for new students. For example, if a student fails a class, then she should be encouraged to learn from her experiences as opposed to giving up, or being told that "engineering isn't for everyone" or that "engineering might not be for you." Additionally, knowing that other students could overcome challenges during their degree programs would be inspiring to new students.

Using Engineering to do Good

Lastly, the women told stories depicting how they can use engineering to improve the lives of others. While in college, women are more likely than men to volunteer (Haski-Leventhal et al., 2008). Similarly, the participants in this study were engaged in activities, like the engineering ambassadors program, to increase participation in engineering. Increasing participation in engineering is a matter of equity because unequal access and success in opportunities for qualified students counters inclusion and access in higher education (Baber, 2015). Not only will increasing women's representation in engineering help mitigate some of the challenges women face, especially regarding gendered bias, increasing women will also invite more women to enjoy the benefits associated with earning a degree in engineering, such as higher salaries. Riley (2013) writes about these feminist engineering ethics where social justice is enacted for women both internally and externally to the field. Internally, feminist engineering ethics promotes equity in engineering, and externally it promotes social justice outcomes to improve the lives of others.

Increasing the number of women in engineering will contribute to the competitiveness of the field and help improve the lives of more people (Blickenstaff, 2005; Hill, Corbett, & St Rose, 2010; Shapiro & Sax, 2011). For example, Margolis and Fisher (2003) detailed several engineering advances that advanced society for men, sometimes at the expense of women (i.e., voice activated systems that only respond to masculine voices or airbags for men that injure women and children). With more women in engineering, the needs of women in society will be better addressed. Regarding improving society, some participants told stories where their female faculty have engaged them in research efforts to help others, like testing pig tendons to improve rehabilitation for tendinitis. Other participants told stories detailing how they plan to use their engineering degrees to improve the lives of others, for example increasing access to clean and affordable energy.

The women's stories in relation to improving the lives of others mostly pertained to their favorite experiences in their degree programs. As a result, in their coursework, faculty should increase real life applications, which benefit society both through formalized service learning programs and in the examples they use to explain concepts. Additionally, colleges of engineering should promote and increase pathways to more engineering careers that benefit society like opportunities in healthcare or infrastructure.

Implications for Future Research

The experiences of women in engineering are unique. Even in this study, the participants had more positive experiences, especially regarding gendered biases, when there were more women in their degree programs. Since engineering degree programs, like those at NC State, are under a college of engineering umbrella, there are more opportunities for positive climates and behaviors to permeate between various programs. This study did not include enough participants to make broad generalizations about women's experiences in the college of engineering at NC State, as this was not its goal; however, it does identify areas where additional attention is needed. The gendered biases and feelings of doubt—feeling like an imposter—are things that degree programs and faculty need to improve for women in engineering. Whereas, the employment of growth mindset principles and a propensity for social justice in engineering are two successful avenues already in existence that can be expanded and enhanced.

The interview protocol included questions to help identify specific institutional barriers to women's participation in engineering. The participants had trouble with these questions because they did not have enough context to address these items. Perhaps a few years after they have graduated these women may be in a better place to understand any institutional barriers they faced. This is an important area of inquiry, but a more appropriate approach would be to support the students through action research to consider how institutional systems like syllabi, course plans, course descriptions, policies and regulations, etc. are gendered and either facilitate or hinder women's advancement through engineering.

Action research could also be used to engage students about sexism, which was a prevalent theme in the stories of the participants even if they indicated it was not. Engaging undergraduate engineering students (especially in the introductory engineering courses where bias is most prevalent) to study sexism and implicit bias, could be a powerful tool to better understand this phenomenon and suggest grassroots, sustainable efforts to combat gendered bias.

This research study took a broad approach to consider women's experiences in engineering. Another potential avenue for research would be to use the imposter syndrome as a lens—combining self-efficacy, self-concept, stereotype threat, and identity threat—to ask more specific questions about these constructs and how they shape women's experiences in engineering. This line of inquiry could be supported with participants drawing an engineer or finding a picture of an engineer to see whether they resemble their depictions.

Due to these women's successful experiences employing a growth mindset, more work is also encouraged in this arena. Specifically, how can engineering programs rebrand the expectations of their programs to encourage learning as opposed to grades, and how can educators teach a growth mindset to their students? In the end, this would be helpful to all genders.

Lastly, feminist standpoint theory defined the need for this study—the assumption that women in engineering have an inferior experience than male students, and their experiences need to be shared. Extent literature corroborated this assumption. If future researchers would like to further explore undergraduate women's experiences in engineering, I propose two final suggestions for future research. As evident to me through this project, the undergraduate women have not had very much time to make meaning of their experiences, so journaling or additional interviews could help facilitate their reflection processes. Then, to more fully develop a concise “standpoint” a follow-up focus group interview could better define a community of knowledge. During the interviews, the women grew through their reflections and developed a better understanding of themselves. Sharing these narratives with others, who might have had similar experiences, would give their narratives more power and provide the women a sense of community that they so often lacked during their undergraduate engineering experience.

Conclusion

This study portrays some of the storied experiences of women in engineering at NC State University, a predominately White research institution. The women in this study highlight several factors which are contributing to the decrease of women’s representation in engineering: implicit and explicit sexism, self-doubt, and a lack of meaningful coursework or pathways to meaningful careers. The stories of participants also identified a strength of the women who have persisted in engineering—a growth mindset. Enacting a growth mindset is a successful practice of women to persist in engineering, but it cannot accommodate for the aforementioned negative factors. These issues need to be addressed before women can make substantial gains in engineering fields, and not for the same of proportions, but because women make valuable and needed contributions to the field.

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A NARRATIVE EXPLORATION OF THE LEARN MODEL: UNDERSTANDING THE LEARNING AND CAREER-SEEKING EXPERIENCES OF WOMEN EARNING ENGINEERING BACHELOR'S DEGREES

Engineers make valuable contributions to society like improving infrastructure (roads, bridges, dams, airports, transport systems, etc.), addressing climate change, and developing new computer software. When women have not been represented in engineering, society has suffered. In one famous example, the first vehicular airbags only fit adult men because they were developed by an all-male engineering team, which lead to the unnecessary deaths of women and children (Margolis and Fisher, 2003). In this case, diverse perspectives could have saved lives by creating a more comprehensive solution. Clearly, expanding diversity by including the ideas of women can help make the engineering field more competitive, healthy, and inclusive of all of society (Blickenstaff, 2005; Hill, Corbett, & St Rose, 2010; Shapiro & Sax, 2011). However, as recently as 2013, women accounted for only 29% of scientists and engineers working in science and engineering occupations (NSF, 2015). Because women's underrepresentation in engineering limits advancements in the field, which affects society, this study considers the learning and career-seeking experiences and trajectories of undergraduate women graduating with degrees in engineering.

Women's underrepresentation in engineering is also limiting for women financially. Nine of the top ten highest paying bachelor's degrees are engineering degrees (the non-engineering top ten major is pharmacy, pharmaceutical sciences, and pharmaceutical administration (Carnevale, Cheah, & Hanson, 2015). Petroleum engineers make the highest annual median wage of $136,000 (Carnevale, Cheah, & Hanson, 2015). In contrast, the lowest earning bachelor's degree is early childhood education, of which, the median annual wage is $39,000 (Carnevale, Cheah, & Hanson, 2015). Per census estimates of full-time year-round employees, 88% of petroleum engineers are male (12% are female), whereas 97% of Preschool and kindergarten teachers and 78% of Elementary and middle school teachers are female (men represent 3% and 22% of those occupations respectively) (U.S. Census Bureau, 2015). While women still make less than men in the same field (on average 80 cents to the dollar) (Proctor, Semega, & Kollar, 2016), as evidence by the above statistics, they also make less than men by not being in the same field. To be clear, education is not a bad career decision for women if that is the career that they would like, but this financial disparity perpetuates male privilege, prestige, and power over women in society.

One popular theoretical perspective to consider the "underrepresentation" of women in STEM fields, because of the aforementioned factors, is the "leaky pipeline" wherein women are exiting the pathway, or pipeline, to a career in STEM at critical junctures (Blickenstaff, 2005; Cannady, Greenwald, & Harris, 2014; Gayles, 2011). These various stages include: when students enter college, and do not choose STEM majors; or they enter college, choose STEM majors, and then switch out; or students go so far as to earn their undergraduate STEM degrees but choose non-STEM careers (Blickenstaff, 2005; Cannady, Greenwald, & Harris, 2014; Gayles & Ampaw, 2016; Griffith, 2010).

The fragmentation of processes in the "leaky pipeline" model is problematic in that it encourages isolating women's experiences in STEM to one time period as opposed to looking at their entire trajectories. The model has also been challenged for being a one-size-fits all, linear model where individuals can only take one pathway to earn a STEM degree, the same pathway for all STEM degrees, and an emphasis is placed on benchmarks as opposed to ultimate results (Cannady, Greenwald, & Harris, 2014; Xie & Shauman, 2003). Cannady, Greenwald, and Harris (2014) found that the pipeline metaphor only fit 50% of the experiences of the students that became scientists or engineers and, as a result, they raise concerns regarding its usage to increase the number of students in STEM in academic studies and resulting public policy. Similarly, Watson and Froyd (2007) highlight that the "leaky pipeline" model, "oversimplifies complexities of the underlying processes, focuses interventions at point of unwanted leakage, and that leaks need to be plugged instead of systems renewed" (p. 19). Wyer (2003) also expresses concern about the pipeline model highlighting deficits and differences instead of viewing women's persistence in STEM as an opportunity for further research, and Miller and Wai (2015) question why women choosing to leave STEM to pursue professions they would prefer is a problem. If women choose to leave engineering because they do not feel like they belong or are welcome, yes, that is a problem; however, if women choose to leave engineering because they are not interested, then they are making a decision—not a problem.

Given the common usage of the "leaky pipeline" model, with little success in increasing the representation of women in engineering, and, an overall insufficient use of theory in engineering education studies (Borrego, 2007; Koro-Ljungberg & Douglas, 2008) a new, extensive theoretical framework is needed. In contrast to the pipeline model, Jaeger, Hudson, Pasque, and Ampaw (2017) propose the theoretically developed Life Experiences and Role Negotiations (LEARN) Model where pathways in STEM are based on a trajectory that accounts for individuals' diverse, multi-contextual, cumulative learning experiences. Where the "leaky pipeline" model focuses on one, singular STEM experience or pathway and on leaks from that pathway at points in time, the LEARN Model addresses the different influences on experience and meaning making of these influences and experiences which can look different for different people.

The purpose of this narrative study was to explore whether Jaeger et al.'s (2017) LEARN Model could be used to understand the learning and career-seeking experiences and trajectories of undergraduate women graduating with degrees in engineering from a Southern, top-tier research, predominately White institution. While Jaeger et al.'s theoretical assumptions are driven by Ph.D. earning women in STEM, this proposed study sought to determine if these assumptions are also useful for understanding a younger, narrower group. The model was expected to remain applicable for this group because the experiences of undergraduate women, although they may be fewer and less diverse, still fit the LEARN Model. For example, extant literature details the continuous personal determinants (e.g., identity, self-concept, and agency) that often act as factors to undergraduate women's persistence in STEM. Additionally, undergraduate women have formal experiences that provide learning and decision-making opportunities regarding their trajectory in STEM such as: living learning programs; co-ops and internships; undergraduate research; and/or summer bridge programs; and informal experiences like interacting with faculty and other students in the classroom. The inclusive nature of the LEARN model suggests that it is an alternative to the “leaky pipeline” metaphor and a viable means to consider the unique experiences of women in engineering.

Literature Review

Reasons for the underrepresentation of women in engineering degree programs, and eventually the engineering workforce, are various and well documented. Insufficient early academic preparation has been attributed to women’s underrepresentation in Science, Technology, Engineering, and Mathematics (STEM) overall (Perna et al., 2009; Lee, 2002; Wentling & Camacho, 2008; Yauch, 1999); however, more recent studies suggest that, instead of preparation, poorer performance in early math and science classes may lessen young women’s interest in STEM disciplines (Cunningham, Hoyer, & Sparks, 2015). Even when students do have positive views about STEM, their experiences in the classroom are often unengaging and can still dissuade them from pursuing STEM (Maltese & Tai, 2010). Society also presents poor perceptions and images of women in science and engineering—where women are not present at all or they are presented as unattractive or unfeminine—which influences women’s choices to pursue STEM (Barman, 1997; Blickenstaff, 2005; Buse, Bilimoria, & Perelli, 2013; Cho, Goodman, Oppenheimer, Codling, & Robinson, 2009; Fort & Varney, 1989; Hartman & Hartman, 2008; Heilbronner, 2012; Steinke et al., 2007; Thomas, Henley, & Snell, 2006; York, 2008).

According to extant literature, once in college, women suffer from a lack of female peer support or role models (Carrell, Page, & West, 2009; Chanderbhan-Forde, Heppner, &

Borman, 2012; Drury, Siy, & Cheryan, 2011; Feeney & Bernal, 2010; Leslie, McClure, & Oaxaca, 1998), and women have lower levels of self-efficacy and self-concept often as a result of their STEM experiences in their first year at college or university (Beyer, Rynes, & Haller, 2004; Brainard & Carlin, 1997; Buse, Bilimoria, & Perelli, 2013; Concannon & Barrow, 2010; Espinosa, 2008; MacPhee, Farro, & Canetto, 2013; Sax, 1994a; Sax, 1994b; Sax, Kanny, Riggers-Piehl, Whang, & Paulson, 2015; Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012; Hathaway, Sharp, & Davis, 2001; Leslie, McClure, & Oaxaca, 1998; Wismath & Zhong, 2014), all of which affects their likelihood to persist in STEM degrees. Similarly, women start to doubt their abilities in the classroom due to a "chilly climate" where they experience discrimination, lack of belonging, and harassment (Allen, 1999; Blickenstaff, 2005; Goldman, 2012). STEM syllabi contribute to a "chilly" climate through unfriendly and competitive language, which mimics the climate of the institution (Mansfield, Welton, and Grogan, 2014; Parson, 2016). These syllabi couple with competitive, masculine teaching pedagogies that seek to "weed out" students (Allen, 1999; Blickenstaff, 2005; Goldman, 2012; Margolis & Fisher, 2002; Seymour & Hewitt, 1997; Suresh, 2006).

Finally, after college, despite earning a degree in STEM, women choose not to pursue a STEM career (Smith & Gayles, in press), or leave STEM employment positions due to conflicts between their roles as mothers, wives, and STEM workers (Heilbronner, 2012; Rascoe, 2005). Hilpert, Husman, and Carrion (2014) report that female engineering students imagine a trade-off between their professional and domestic lives. Women leave engineering for other professional fields at a higher rate than most disciplines due to the larger proportion of men and pay and promotion opportunities (Hunt, 2016). Women also confirm leaving STEM positions due to social isolation and incompatibility with family responsibilities (Heilbronner, 2012; Rascoe, 2005). Kahn and Ginther (2015) indicate that single, childless women are the most likely to persist in engineering. Census findings further support these assertions where, among STEM workers, 57% of males and 62% of women have no children (Landivar, 2013). Not long ago, women in engineering also indicated that they were often mistaken as secretaries, earned lower salaries than their male colleagues, and watched men ascend professional ranks more quickly (Barker, 2001).

In sum, previous research indicates that women are made to not feel welcome in STEM—when they are young and do not see many portrayals of female scientists, or later in life when they are studying at university or in the workforce and do not have many women around them in their discipline. Women also feel unwelcome in college or university STEM courses, especially engineering, that are competitive, masculine, and “chilly.”

The LEARN Model

Jaeger et al.’s (2017) Life Experiences and Role Negotiations (LEARN) Model’s holistic approach to consider the lifelong experiences of women in science, technology, engineering, or mathematics (STEM) shows that women in STEM do not have one clear *path* or *endpoint*. This dynamic, multidimensional approach suggests that everyone’s experiences are different. Because of this flexibility, the LEARN model can be complicated to explain and comprehend. To help overcome this challenge, in the following sections, each of the model's four main influencing theories will be introduced and then mapped to the relative model components as they relate to a subject of this study—an undergraduate in the final year of her engineering program, in this case, Sheila, a fictional electrical engineering student. Sheila is a composite character based on multiple interviews with engineering undergraduates—she does not represent any one study participant to not make any participants identifiable. These theories are presented in order of their influence on one another as opposed to in order of LEARN Model elements, which are cyclical and reflexive, meaning that while Jaeger et al. (2017) created a sequence to the model, there is not one starting point.

Before being able to delve deeper into the LEARN Model, more information is needed about our fictional friend, Sheila, a fifth-year senior in electrical engineering: *after completing her electrical engineering degree, Sheila will work for Cree, a company near her school that makes LED lighting and semiconductor products. Sheila completed a co-op at Cree, after which the company offered her a job upon her graduation. She accepted Cree's offer as she really enjoyed her experience there. As for Sheila's family, her father earned his degree in Computer Science and works at Lenovo, a company that produces personal computers and electronic devices, and her mother is a math instructor at the North Carolina School of Science and Mathematics (NCSSM). Sheila has an older brother who attended NC State University, like she does, and is a computer programmer at IBM. Recently, Sheila's brother and sister-in-law gave birth to a daughter.* To find out more about Sheila and how her experiences and trajectory illustrate the LEARN Model, read on.

The Life-span, Life-space Theory of Career Development

Regarding the first theoretical influence of the LEARN Model, elements of Super's life-span, life-space theory of career development account for the LEARN Model's determinants and role expectations. Super's (1980) work introduces the simultaneous combinations of career decision-making points over one's lifetime, which are affected by unique personal determinants (i.e., biology, attitudes, values, and intelligence) and situational determinants (i.e., geography, history, and socioeconomic status). Super indicates the life-span, life-space theory could help people analyze their own careers. Super's (1980) concept of determinants make-up a significant portion of the LEARN Model, which groups personal and situational determinates into three categories: past, present, and continuous personal determinants. When looking at Jaeger et al.'s (2017) model, the continuous personal determinants can be found in the uppermost arrow that continues along a woman's entire trajectory. While not specifically mentioned in Super's life-span, life-space theory of career development, Jaeger et al.'s continuous personal determinants (the uppermost arrow) include identity, self-concept, and agency.

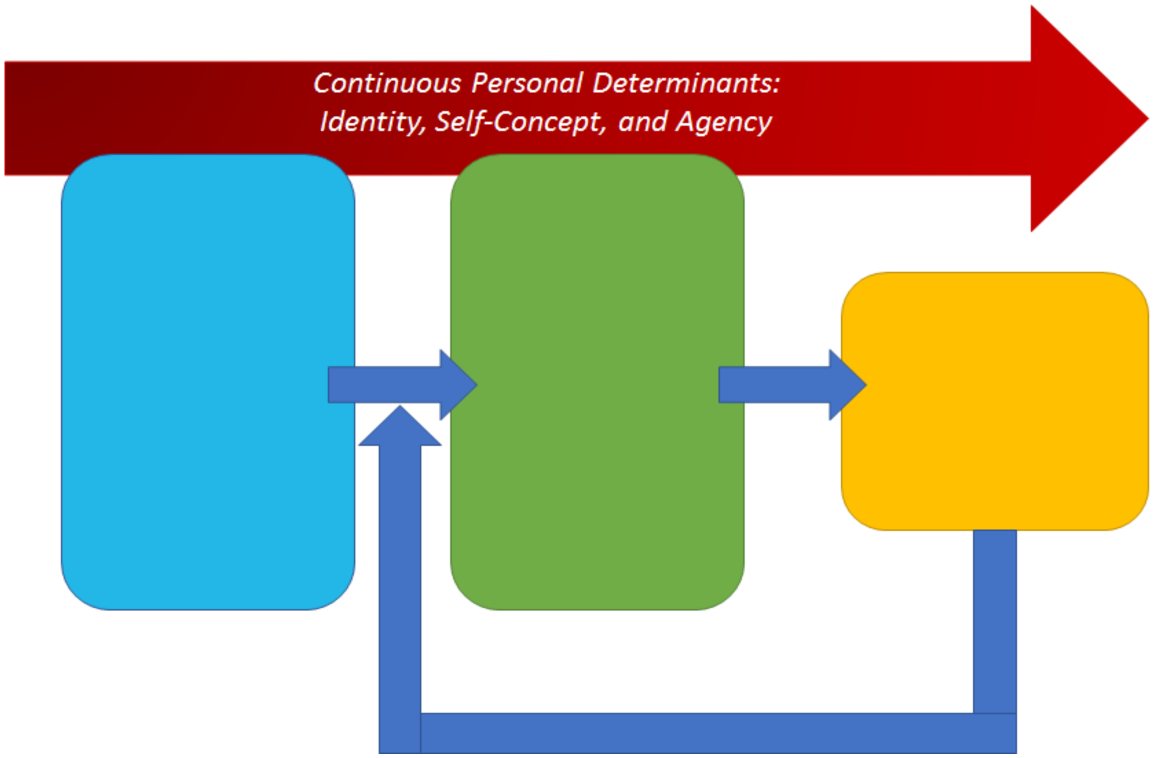

Figure 2.1. Continuous Personal Determinants. Adapted from "Understanding How Lifelong Learning Shapes the Career Trajectories of Women with STEM Doctorates: The Life Experiences and Role Negotiations (LEARN) Model" by Jaeger et al. 2014. Paper presented at the *Association for the Study of Higher Education*: Washington, D.C.

Identity. In the LEARN Model, Jaeger et al. are concerned with two types of identities: sociocultural identities and science identity. For example, Sheila has sociocultural identities (race, gender, ethnicity, etc.), she is a White, female engineering student from an affluent area of North Carolina. She also has a science identity based on performance, recognition, and competence (Carlone & Johnson, 2007). In Carlone and Johnson's (2007) model of science identity, performance relates to, "social performances of relevant scientific practices" (p. 1191), recognition is the combination of one's own self-perceptions and perceptions from meaningful others, and competence is expertise over science content.

Sheila's science identify is a product of her self-perception of her success in engineering, the feedback she receives from teachers, parents, professors, and/or employers, and her mastery of engineering. Together, Sheila's sociocultural identities and science identities interact and act as continuous personal determinants that affect the career-decision making points through her lifetime and trajectory in engineering. Based on these interactions in the LEARN Model, if Sheila receives low levels of recognition from her peers and faculty due to her gender identity, she may have a lesser science identity. This lesser science identity can, in turn, make Sheila feel like she is not in the right field and affect her decision to persist in engineering at any time in her life, or, at any time along her trajectory.

Self-concept. Related to Carlone and Johnson's (2007) science identity, and especially the element of self-recognition, self-concept pertains to one's perception about her performance relative to her peers' performance. Many women in college have a lower self-concept about their performance in STEM because of poor interactions with faculty, insufficient support from faculty, lower grade point averages than in high school, and challenging classroom environments (Espinosa, 2008; Sax, 1994a; Sax, 1994b; Sax et al., 2015). How a woman perceives she is doing, irrespective or her actual performance, can also affect her decision to persist in engineering at any point (Espinosa, 2008; Sax, 1994a; Sax, 1994b, Sax et al., 2015). For Sheila, a feeling of underperformance, like she is not doing as well as everyone else in her classes, similar to a low science identity, could affect her decision to persist in engineering at any time in her life or at any time along her trajectory.

Agency. The last continuous personal determinant listed in the LEARN Model's uppermost arrow is agency. Agency is one's use of strategic perspectives and/or actions towards one's goals (O'Meara, Campbell & Terosky, 2011). In this way, like identity and self-concept, agency, and the strategic perspectives or actions that Sheila takes, like whether she takes a resilient, strategic perspective to deal with challenges, like when she fails a Physics class she decides to take it again, or like when she pursues an opportunity, like an internship at Cree, that she thinks will benefit her, can affect her career related learning and decision making at any point in her trajectory. Also, according to Jaeger et al. (2017), "one of the ways that women exercise agency in their careers is through the decisions-making process itself" (p.18). As a result, a women's agency is not only the actions she takes to reach her goals, but also her process for choosing to take those actions.

Role expectations. Moving outside of the uppermost arrow, in addition to personal determinants, Super (1980) introduces role expectations which Jaeger et al. place in the LEARN Model's final, yellow, future career outcomes box. To Super, people play a variety of roles (i.e., child, student, parent, employee, etc.) throughout their lives, and the constellation of some of these professional roles over one's lifetime constitutes a career. Role expectations can be both what an individual envisions for her roles and what outsiders also expect about the individual's performance in said role. As for Sheila's role expectations, she is currently a child and student but in the future she will have new roles: employee and perhaps parent and/or spouse. Sheila and others have expectations about her roles and what those roles will entail. For example, if she would like to have children, then Sheila has expectations about her future role at Cree and the company's policies for work/life balance and how they might affect her ability to have children.

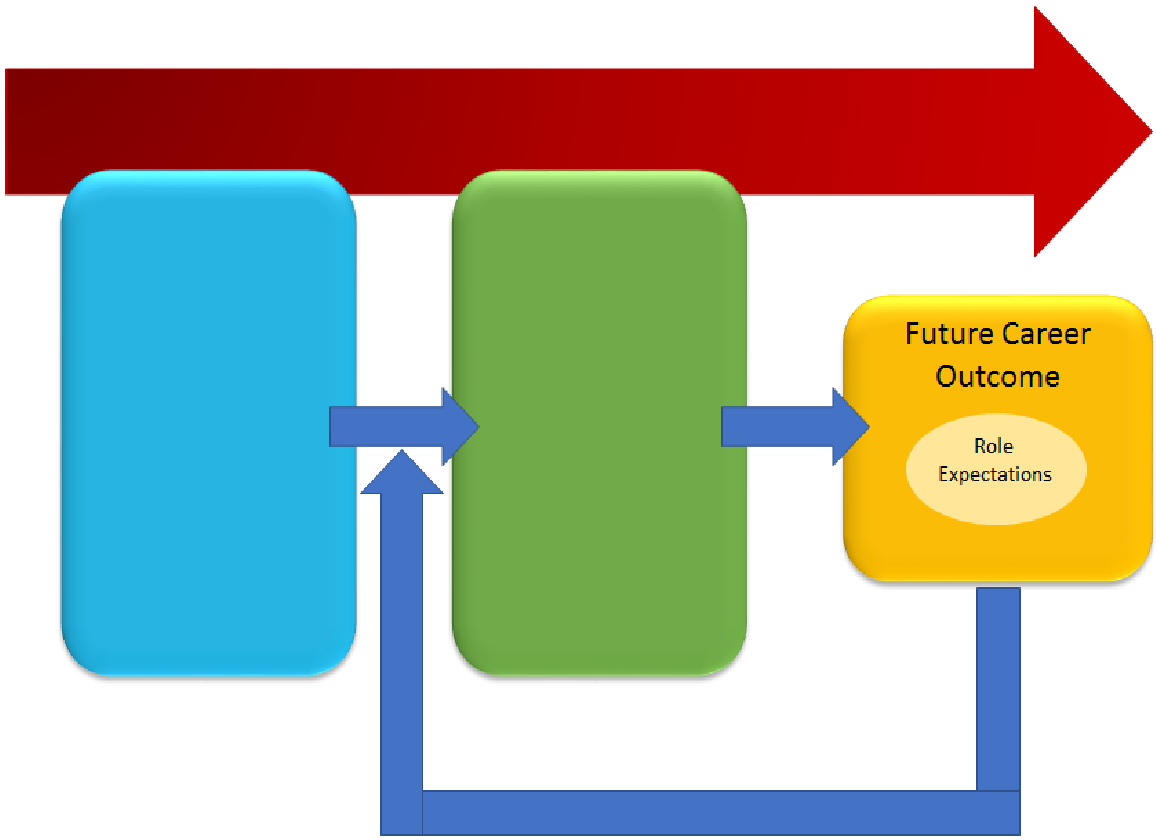

Figure 2.2. Role Expectations. Adapted from "Understanding How Lifelong Learning Shapes the Career Trajectories of Women with STEM Doctorates: The Life Experiences and Role Negotiations (LEARN) Model" by Jaeger et al. 2014. Paper presented at the *Association for the Study of Higher Education*: Washington, D.C.

The Life Designing Model

Building on the self-actualization work of Super (1980), Savickas et al. (2009) propose a lifelong, holistic, contextual, and preventative life-designing interventions framework where an individual writes her own complex career narrative. In his study, Guichard (2009) demonstrates one such life-designing intervention, career-counseling interviews, where individuals narrate their past careers and goals for the future. Like Guichard, Hartung (2011) builds upon the narrative concept to address the role of emotions, which she finds underrepresented in Savickas et al.'s model, and their relationship to memory and intentionality in life-designing. From the life-designing interventions framework, Jaeger et al. (2017) emphasize the importance of the environment and congruence, adaptation, and marginalization in the women's experiences and trajectory towards a career in STEM. Visually, the environment is present in every box of the model and congruence, adaptation, and marginalization can be found in the blue arrow that cycles back as a feedback loop from one's future to her past.

Environment. Savickas et al. (2009) argue that human behavior is a product of the environment, and that in a rapidly changing environment, "theoretical models are needed that emphasize human flexibility, adaptability, and lifelong learning" (p. 240). The LEARN Model aims to accomplish this by including the environment as an element to consider in all three boxes or sequential levels—the past, present, and future. In this way, environmental changes, how one interprets these changes, and how one interacts with these changes can be significant in shaping one's career trajectory (Savickas et al., 2009). For Sheila, the experiences of her family in STEM careers, and opportunities to be engaged in STEM from a young age through her parents, influences her engineering trajectory if she responds positively and engages in these environmental changes.

Congruence, adaptation, and marginalization. In relation to her environment, Sheila can feel congruence with her values and those around her (Savicakas, 1997) (she might think that engineering is fun), she can adapt to foster this congruence (she might think that she will learn to love engineering once she finds her niche), or she can feel marginalized and unable to function within her environment (she might think that she cannot survive in engineering, she wants to be a writer). Through these three environmental responses, Sheila continues to learn and make decisions about her career trajectory (Jaeger et al., 2017). As a result, congruence, adaptation, and marginalization act as a feedback loop in the LEARN Model to stress both the importance of the environment in one's career trajectory in engineering and also how one interacts with said environment (Savicakas et al., 2009).

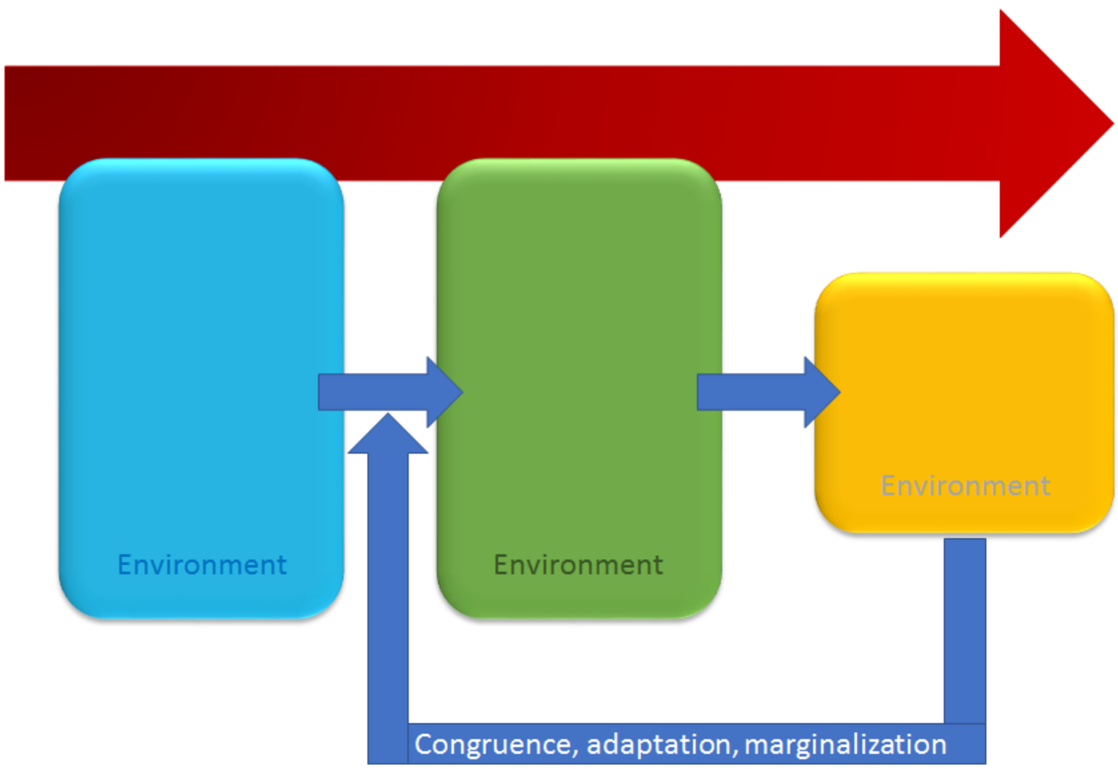

Figure 2.3. Environment. Adapted from "Understanding How Lifelong Learning Shapes the Career Trajectories of Women with STEM Doctorates: The Life Experiences and Role Negotiations (LEARN) Model" by Jaeger et al. 2014. Paper presented at the *Association for the Study of Higher Education*: Washington, D.C.

Social Cognitive Career Theory

Unlike Savicakas et al.'s (2009) life designing model, Lent, Brown, and Hackett's (1994) Social Cognitive Career Theory (SCCT) addresses the role of emotions (Hartung, 2011). SCCT posits that career and academic interests are a response to one's self-efficacy and value of outcome expectations, which, in turn, affect academic and career outcomes. Due to SCCT's robust operationalization, it has been tested frequently (see: Brown, Lent, Telander, & Tramayne, 2011; Conklin, darling, & Garcia, 2013; Lee, Flores, Navarro, & Kangxi-Muñoz, 2015; Lent, Lopez, Shed, & Lopez, 2011). These cited studies generally find SCCT to be a good fit in describing the experiences of students in STEM, especially engineering. Due to this, elements of SCCT are included as key components of the LEARN Model, such as, goal representations, self-efficacy, and outcome expectations.

Goal representations. In the LEARN Model, the uppermost circle in the present determinant box is goal representations. According to Lent, Brown, and Hackett (1994), "by setting goals, people help to organize and guide their behavior, to sustain it over long periods of time even in the absence of external reinforcement, and to increase the likelihood that desired outcomes will be obtained" (p. 6). Examples of Sheila's goal representations include her plan to major in engineering, pursue an engineering internship at Cree, and secure a job at Cree post-graduation.

Self-efficacy and self-assessments. Another present determinant for the LEARN Model is self-efficacy and self-assessments. Self-efficacy is a dynamic belief resulting from a self-assessment of one's own ability in a performance domain (Lent, Brown, & Hackett, 1994). This ability in a performance domain is one's confidence in her capability to figure out what needs to be done and do it in specific contexts. These contexts can relate to solving complex math problems or pursuing an opportunity for career advancement in engineering. If Sheila has low levels of self-efficacy in her ability to do well in engineering, she may be less likely to pursue challenging engineering opportunities.

Outcome expectations. Lent, Brown, and Hackett (1994) delineate outcome expectations, the last present determinant in the LEARN Model, from self-efficacy in that, "self-efficacy beliefs are concerned with one's response capabilities (i.e. 'can I do this?), [whereas] outcome expectations involve the imagined consequences of performing particular behaviors (i.e. 'if I do this, what will happen?)" (p. 5). As such, outcome expectations take things one-step farther than self-efficacy. If a woman has high self-efficacy and self-assessment of her engineering ability, she is likely to have high expectations about what she thinks will happen if she pursues a challenging engineering opportunity. Sheila's high levels of self-efficacy and self-assessments of her engineering ability means she thinks she is likely to do well working at Cree. In the LEARN Model, the relationship between goal representations, self-efficacy and self-assessments, and outcome expectations is cyclical. Since Sheila successfully obtained a position at Cree, she is likely to self-assess her engineering ability higher, and, as a result, have higher outcome expectations for herself in the future, such as becoming a manager, an accomplishment that would, in turn, start the present determinant loop again. Unfortunately, environmental factors, and one's emotional response to them, can cause this cycle to be negative as well. For example, insert a poor supervisor into Sheila's Cree experience and her self-efficacy, self-assessments or future in engineering may falter. Further, Sheila's present determinants are likely driven by the lessons that she has learned from the past, or the LEARN Model's past determinates, which come from the social learning theory of career decision-making.

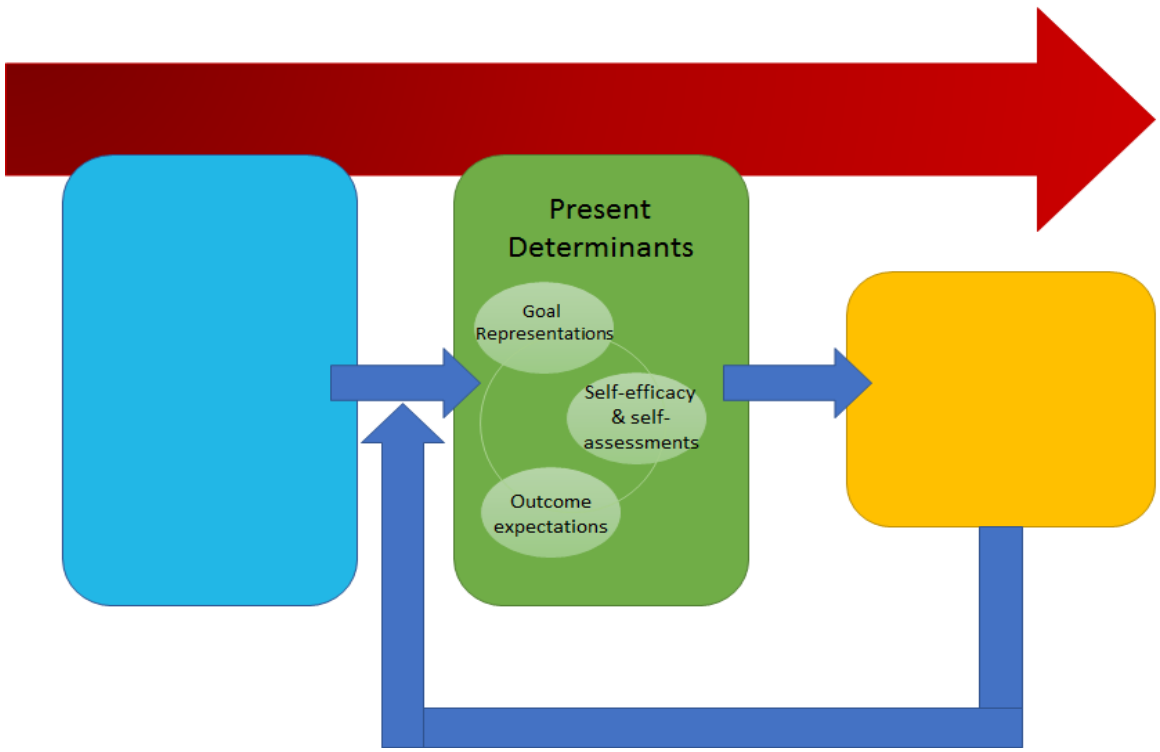

Figure 2.4. Present Determinants. Adapted from "Understanding How Lifelong Learning Shapes the Career Trajectories of Women with STEM Doctorates: The Life Experiences and Role Negotiations (LEARN) Model" by Jaeger et al. 2014. Paper presented at the *Association for the Study of Higher Education*: Washington, D.C.

The Social Learning Theory of Career Decision-making

In Krumboltz's (1994) social learning theory of career decision-making (SLTCDM), learning experiences—both direct and indirect—drive one's beliefs and actions. Krumboltz emphasizes choice behavior whereas Lent, Brown, and Hackett (1994) focus on the interrelated processes of interest development, choice, and performance. As a result, Lent, Brown and Hacket critique Krumboltz for underemphasizing the roles of self-efficacy and goal setting. Jaeger et al. make sure to emphasize these constructs in the LEARN Model; instrumental learning experience, associative learning experiences, and schemata—all elements of SLTCDM—make up the LEARN Model's past determinants, or the first, blue box.

Instrumental learning experiences. According to SLTCDM, with instrumental learning experiences, individuals develop an aversion or affiliation with things depending on their experiences. These experiences can be driven by a sense of reward or a punishment. For example, if Sheila attends a study session for an engineering class and the teaching assistant or another student makes a sexist joke, then she could develop an aversion to engineering study sessions. This aversion, in turn, could prevent her from seeking help with her coursework in the future, which ultimately could affect her academic performance or her choice to remain in engineering.

Associative learning experiences. In contrast, associative learning experiences are those that are driven by society (Krumboltz, 1994). Women are less likely to pursue an engineering degree because they do not think it aligns with traditional gender-norm expectations like marriage and procreation (Blickenstaff, 2005; Buse, Bilimoria, & Perelli, 2013; Hartman & Hartman, 2008; Heilbronner, 2012; York, 2008). An example of an associative learning experience, then, is when Sheila's sister-in-law leaves her career as a software engineer at SAS to care for Sheila's newborn niece, whereas, Sheila's brother continues his career. In sum, “different careers and activities carry positive or negative (or even contradictory) social messages about values and norms” (Jaeger et al., 201, p.10), and these messages are used to construct schemata.

Schemata. Schemata are hypotheses that are used to interpret societal events. They are, “similar to stereotypes, but the term schema is more inclusive, more neutral” (Valian, 2007, p. 32). In response to both instrumental and associative learning experiences, Sheila develops schemata or theories about the world around her and self-perceptions as to how she fits into this world that ultimately shape her career goals. Returning to the most recent example, if she expects to get married and start a family after graduation, why would she pursue strenuous engineering coursework instead of another degree program? Or, what degree and career path would be more supportive of her family expectations and ambitions?

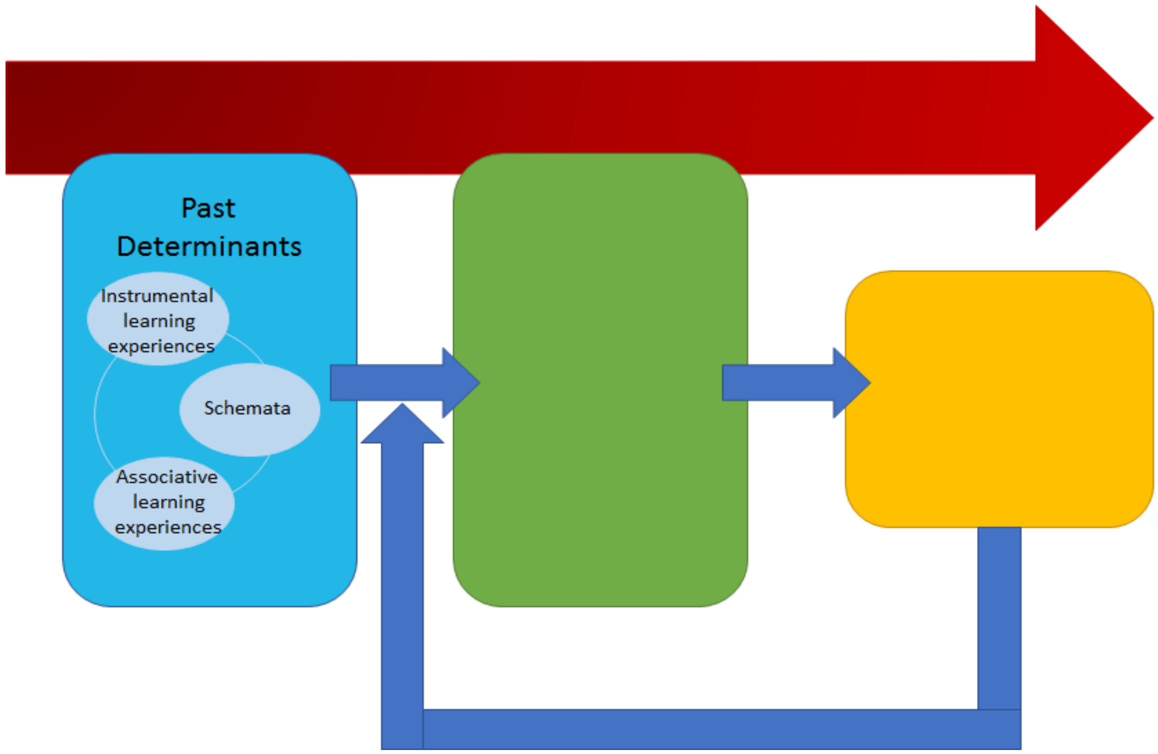

Figure 2.5. Past Determinants. Adapted from "Understanding How Lifelong Learning Shapes the Career Trajectories of Women with STEM Doctorates: The Life Experiences and Role Negotiations (LEARN) Model" by Jaeger et al. 2014. Paper presented at the *Association for the Study of Higher Education*: Washington, D.C.

In the LEARN Model, like the present determinants, these past determinants are again cyclical. Changes in the environment and/or new instrumental or associative learning experiences can challenge Sheila's schemata. Additionally, the learning that she develops from these past experiences then affects her present determinants. Because of this connection, in the LEARN Model, learning represents its own arrow connecting the past and present determinant boxes. A final arrow, decision, connects the present determinants to future outcomes. The concept of decision points and choosing to remain in engineering is drawn from all the theories discussed above.

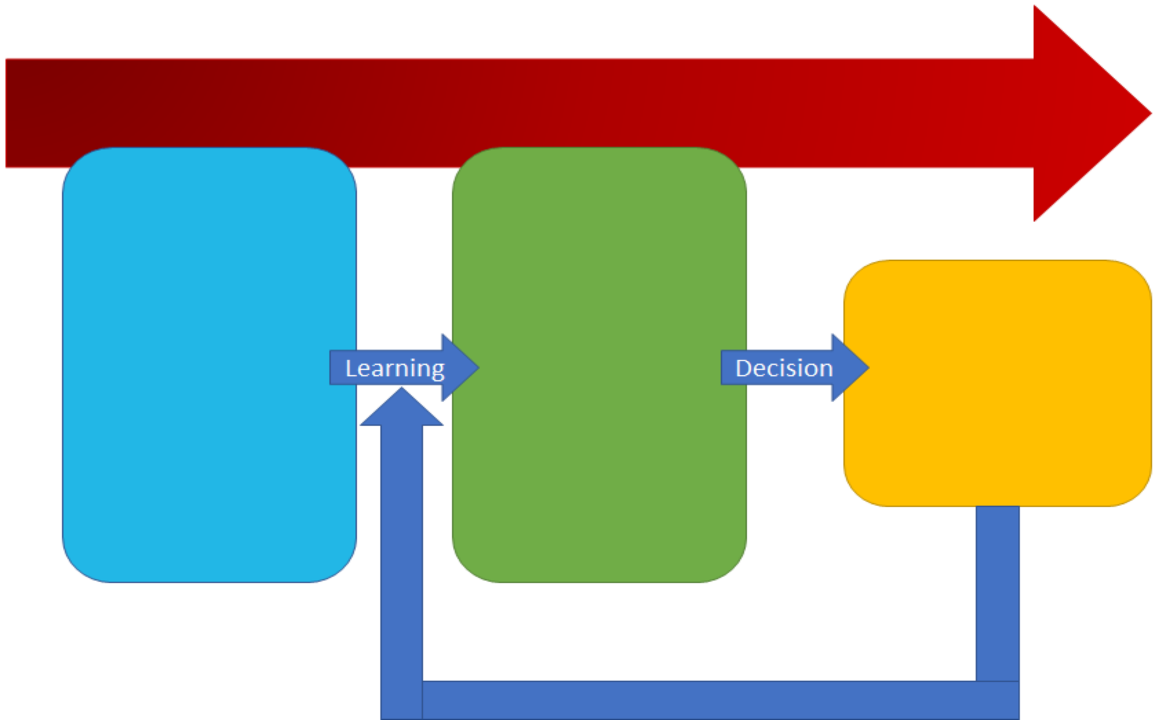

Figure 2.6. Learning and Decision. Adapted from “Understanding How Lifelong Learning Shapes the Career Trajectories of Women with STEM Doctorates: The Life Experiences and Role Negotiations (LEARN) Model” by Jaeger et al. 2014. Paper presented at the *Association for the Study of Higher Education*: Washington, D.C.

In summary, Jaeger et al.’s LEARN Model seeks to understand the unique, individual, lifelong, multi-contextual, continuous experiences of females in STEM. For Sheila, her identities (White female engineer, etc.), her self-concept (how she perceives she is doing in engineering compared to her peers), and her agency (or the strategic actions and perspectives that she takes) are continuous personal determinants she has negotiated in the past and will continue to negotiate in the present and future. Her past determinants are made-up of instrumental learning experiences (good and bad events and interactions), schemata (what society suggests), or associative learning experiences (what Sheila learns from her environment) from which she has either a positive or negative experience. Sheila learns from these past determinants which, in turn, affect her present determinants—what goals she sets for herself, her level of self-efficacy and how she assesses herself, and what outcomes she expects for her actions. Based on these present determinants, Sheila makes decisions about her future career outcomes (whether she will stay in engineering) based on what role expectations she has for herself. These Role expectations filter back to Sheila's learning as she assesses her congruence, adaptation, or marginalization with the environment. A full representation of these elements together is included in Figure 2.7.

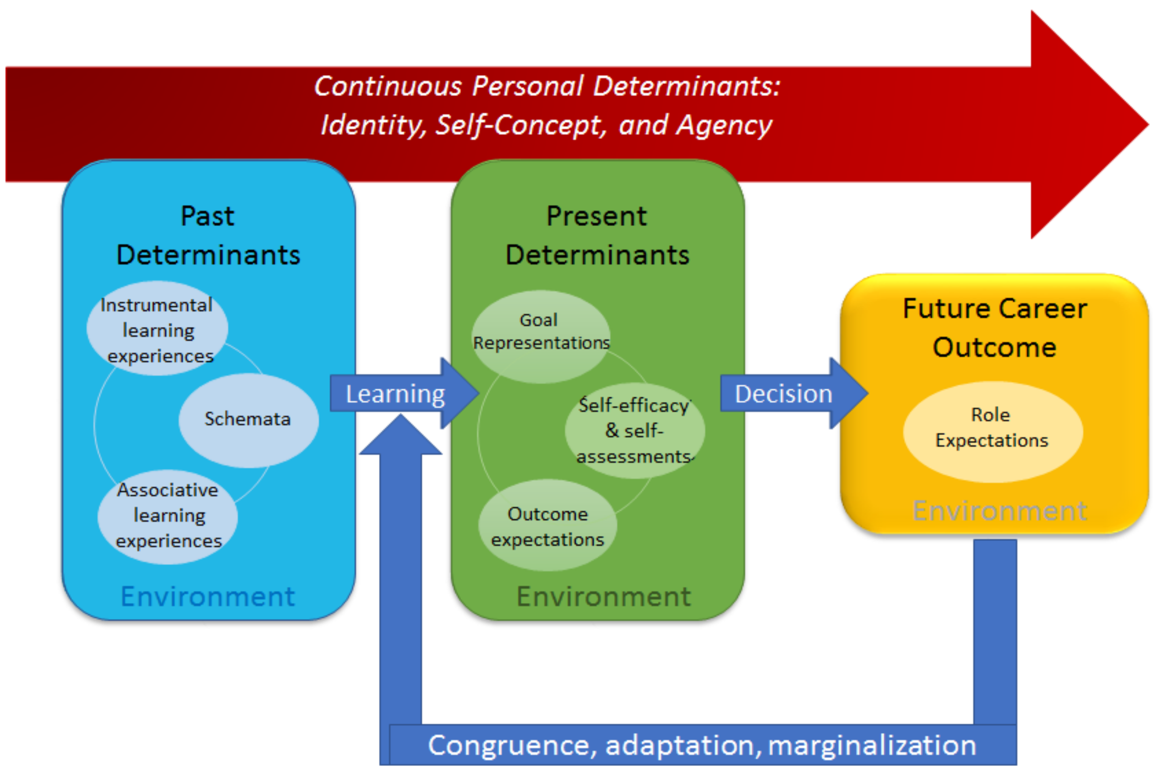

Figure 2.7. The Life Experiences and Role Negotiations (LEARN) Model. Adapted from "Understanding How Lifelong Learning Shapes the Career Trajectories of Women with STEM Doctorates: The Life Experiences and Role Negotiations (LEARN) Model" by Jaeger et al. 2014. Paper presented at the *Association for the Study of Higher Education*: Washington, D.C.

Research Design

Criticism of the “leaky pipeline” model centers on its inability to tell the unique, individual stories of women in STEM. Merriam and Tisdell (2015) suggest that qualitative research is necessary when existing perspectives, like the “leaky pipeline” metaphor, fail to explain a phenomenon. As a result, given the previous insufficient exploration of the experiences and trajectories of women in engineering, qualitative research methodology is needed.

Qualitative research affords iterative designs that generate nuanced data, allowing the researcher to meet participants where they are in their own contexts (Namey & Trotter, 2014). Instead of focusing on the perspective of the researcher, qualitative research is interested in self-interpretation, reflection, and meaning making of experiences by participants (Merriam & Tisdell, 2015). In this way, qualitative research can be open-ended, not manipulative, looking at the whole phenomenon, and assuming that each individual is unique (Patton, 1990). These are all factors that will benefit the exploration of the experiences of women in engineering, a population that, as previous literature demonstrates, needs affordances for participant-level variability. Furthermore, these are all factors, which will also help to address shortcomings of the “leaky pipeline” metaphor, which inadequately addresses the experiences of all women in engineering.

Of qualitative research approaches, a narrative design is the most suitable method to explore and honor someone’s life experiences (Clandinin, 2014; Creswell, 2013), like this study proposes to do. According to Clandinin and Connelly (2000), narrative inquiry is grounded in Dewey's (1938) theory of experience where, "Dewey's two criteria of experience—interaction and continuity enacted in situations—provide the grounding for attending to a narrative conception of experience through the three-dimensional narrative inquiry space with dimensions of temporality, place, and sociality" (Clandinin, 2014, p. 12). Through these means, narrative research emphasizes turning points—called "decision points" in the LEARN model—and allows participants to use these points to illustrate their trajectories, emphasizing what they find important along the way (Elliott, 2012).

Participants and Site Selection

Participants in this study were women soon to graduate from NC State, a predominantly White, land grant, tier-one research institution in the South. As a land grant institution, true to its mission, NC State supports a wide range of agriculture, science, and engineering programs (Marcus & Geiger, 2015). The study participants were selected through purposeful sampling (Merriam & Tisdell, 2015), where they met the following criterion: self-identification as a woman, full-time enrollment in an engineering degree program at NC State, enrollment at NC State for at least three consecutive years, at least a 2.0 GPA, and senior status with the intention to graduate within the current academic year.

Potential participants received an email announcing the study, which included participation criterion, incentive information ($10 Starbucks gift card), and instructions for contacting the researcher to volunteer as a participant. Emails were sent by program managers of engineering support programs including the Goodnight Scholars Program, a scholarship program for middle-income students interested in pursuing a STEM degree, Women in Science and Engineering (WISE), a living-learning village for women in STEM, the Engineering Village, a co-ed living-learning village for freshman interested in engineering, Minority Engineering Programs, a resource for African-American, Native American and Hispanic students who want to become engineers or computer scientists, and TRIO Student Support Services STEM, a college retention and degree completion program for under-resourced undergraduate students pursuing degrees in STEM. Program managers also posted fliers in their offices to help recruit participants for the study.

All 11 participants that emailed the researcher to express an interest in the study were confirmed eligible after presenting their unofficial transcript. The unofficial transcript confirmed their enrollment in an engineering major, their academic status, GPA, and any transfer credits. Table 2.1 lists the participants pseudonyms and respective majors. All the participants were 21 to 24 years of age. In response to a demographic questionnaire (Appendix A), eight of the participants identified as White, one of the participants identified as African American, one identified as "a type of brown not captured by the U.S. census," and another identified as two or more races.

Table 2.1

Participant Information

Pseudonym	**Engineering Major**
Tiffany	Aerospace Engineering
Laura	Biomedical Engineering
Alyssa	Chemical Engineering
Joy	Chemical Engineering
Sam	Chemical Engineering
Penny	Computer Science
Audrey	Industrial Engineering
Deb	Industrial Engineering
Kelley	Industrial Engineering
Meghan	Mechanical Engineering
Christina	Nuclear Engineering

Data Collection

The main source of data for this study were one-on-one interviews between participants and the researcher. Interview questions specifically addressed elements of the LEARN Model including the participants' pasts, presents, and futures, respectively. This approach supports Hollway and Jefferson's (2000) assertion that the best questions for narrative interviews are those that prompt participants to speak about specific times and situations, and prompt participants to share narratives or stories about their lives. To help hone in on specific times and locations, for this interview, participants also brought an artifact for each of the three stages—the past, present, and future. Examples of artifacts included a photo of the participant doing something engineering related, a brochure or website from an engineering program that she participated in, or her resume. Namey and Trotter (2014) identify this as a visual elicitation technique wherein the artifact provides a stimulus for the participant. For the participants of this study, the artifacts helped the women hone in on a single time-period for each interview. In a sense, the artifacts acted as props for the participants to share their stories, and are only detailed in the next section when they play a role in the participants' stories. Furthermore, this interview's protocol is included in Appendix D.

Data Analysis

To explore if the LEARN model could be used to understand the learning and career-seeking experiences and trajectories of undergraduate women graduating with degrees in engineering from a Southern, top-tier research, predominately White, the materials from the interviews were coded using elements of the LEARN Model. These codes included: identity-sociocultural, identity-science, self-concept, agency, instrumental learning experiences—both positive and negative, schemata, associative learning experiences, goal representations, self-efficacy, outcome expectations, role expectations, learning, decision-making, congruence, adaptation, and marginalization. The materials underwent multiple rounds of coding and the researcher enacted detailed memoing to ensure consistency and understanding (Merriam, 2002; Lincoln & Guba, 1985). While additional coding mechanisms may also be appropriate to make sense of these women's storied experiences, the study seeks to explore the LEARN Model. Stories that could not be coded to the LEARN model were highlighted and analyzed further to identify gaps in the model.

Researcher Positionality

For this study, I, the researcher, am a White female that does not have an academic background in engineering. Despite not studying engineering, I have worked professionally with engineering students for almost a decade, and, during my doctoral student tenure, I have participated in numerous studies addressing issues affecting women in STEM. In narrative inquiry, Clandinin (2014) proposes that researchers never fully exit the participants' lives. As a result, I have endured to isolate my role, and the role of this study, in the participants' narratives.

Participants' Stories Through the LEARN Model

This study is framed by Jaeger et al.'s (2017) Life Experiences and Role Negotiations (LEARN) Model, so the participants storied experiences are grouped by the different model components. These model components make up the themes of this study and include continuous personal determinants, the environment, past determinants, learning, present determinants, decisions, and future career outcomes. However, since the model is cyclical, the women's stories often extend beyond one model component. Additionally, the women's stories did not always map on to the model, especially in the ways that people and resources influenced the women’s decisions to stay in engineering. These gaps are discussed further in the next section, Implications for Theory.

Continuous Personal Determinants

According to the Jaeger et al.’s (2017) LEARN Model, a woman's continuous personal determinants are made up of her identity, her self-concept, and her agency. These elements can affect a woman's engineering trajectory at any point of her life.

Identity. To Jaeger et al. (2017) a women’s identity is comprised of her sociocultural identities and her science identity, which for Carlone and Johnson (2007) is a complication of interest, competence, and recognition in science. The women were asked in what ways their identities influenced their participation in engineering. For Alyssa, her sociocultural identity as a woman influenced her participation in engineering because it made her more determined:

> Just knowing that there aren't a lot of women in engineering, I think that just kind of helped me. It made me more determined to be an engineer, knowing that there weren't a lot and I wanted to be one of the few that are. Then hopefully when I get into a position where I have more influence, I can bring other women into the engineering programs or get them excited about STEM. I know, I'm already starting on my niece, just giving her little science-y little things to work on.

For Alyssa, her gender identity influenced her decision to pursue engineering. Whereas two of one of the participant’s identities, the intersection of her race and gender, did not deter her decision to pursue engineering, but they made her experiences more challenging:

> I am a female and I am an African-American female. I think overcoming the female aspect is a lot easier, but since I fell into two minority categories, it kind of can be difficult just because you don't see people like you in your classes. I grew up not seeing people like me in my classes, so at this point it doesn't bother me like it may bother other people who went to high schools where they weren't the minority.

This participant describes how she could cope with her experiences—because she was used to it. Due to this feeling of being the only African American female in your engineering class, others might make the decision to leave engineering. Lastly, Kelley's Christian identity helped her connect her passion and her major:

> I like to think about others more because I identify as a Christian and I think that's something really important. I value what the bible says, "You need to help others."; That was something that engineering really stood out to me because it's something like, "Of course it's helping others."; It's improving the world. It's making things better not just for one person but for a lot of people. It's making things cheaper so that more people could buy them if they need it. It's making lines quicker so that especially in an emergency room or something like that where time is precious. Even if it's a simple solution like in Disney World, let's make the lines shorter. It's improving their experience. It's making people happy.

Kelley sees engineering as a way to help people, and, in return, meet the values she sets for herself via her Christian identity. These stories demonstrate a few ways sociocultural identities have influenced women's decision to stay in engineering.

These same women also discussed their science identity—whether they recognized themselves as an engineer or thought others regarded them as an engineer. Alyssa thinks she fits the image of an engineer:

> Everybody always has an idea of how engineers are supposed to act. Everybody says, "Oh, yeah. You really fit that engineer image", just being kind of reserved, very logical, very... you like to think about what you're going to do before you actually do it. Just very grown up for your age, I guess. I'm not the kind to go out and party, more a stay at home and hit the books kind of person.

Like Alyssa, many of the women used stereotypes of engineers, like a preference to study as opposed to go to a party, to describe themselves. The participants also mentioned external validation for whether they were an engineer or should stay in engineering. For the African-American participant, this was positive:

> I mean, obviously I was accepted into engineering for a reason, so I'm more than capable of doing the work. It's just, it is a hard field, so you have to just put the time into it. If NC State believes that I'm capable of being in the program, then I need to be believe in myself that I'm capable of finishing the program.

She indicates, despite her self-doubt, she has earned a place in the engineering program so she should start to believe in herself more. Whereas Kelley experienced external disagreement with her identity as an engineer:

> In our engineering 101 class we had someone come in and he's like, "Who here is an engineer?"; Everyone raises their hand. It's engineering 101. He's like, "False. You

> are an engineering student."; I was like, "That's really true."; I think that was something that resonated with me because it's funny. You're like, "But no, I'm an engineer."; It's like, "No, you're not an engineer yet."; You're learning how to be an engineer. Although a big part of me, is I like to say I think like an engineer. Especially I'll be waiting in line at the airport I'm redesigning things in my head. I could fix this. I can make this line shorter and things like that. I identify as an engineer the way that I think but I don't call myself an engineer yet and I think that's something that other people don't care about but it's important to me. I'm still in training.

In Kelley's description, she indicates some conflict regarding her engineering identity. If that person had not made a point to call the engineering 101 students out for saying they were engineers as opposed to engineering students, would she think differently? Many of the women told stories denoting they "think like an engineer." These moments of feeling like an engineer, in addition to negotiating their sociocultural identities, led the women to be challenged or choose to persist in engineering. This constant identity negotiation is a continuous personal determinant.

Self-Concept. Another continuous personal determinant is the women's self-concept, or how they perceive their performance in engineering compared to their peers. This self-concept is evident in the women's stories about their pasts. For example, Christina spoke of her self-doubt in high school:

> I doubted myself a lot my senior year in high school because I knew that I was not at the level that other kids were. I knew I wasn't in the classes that they had at their schools. I knew I didn't have the opportunities they did. I'm trying really hard. I know like I don't have AP Calculus BC. These kids are going to be in Calc 1 with me and they're like, "Yeah, we already know all this. We're sleeping, because this is easy." I'm like, "Oh." I definitely doubted myself a lot then, just because I knew that, I knew what kind of caliber of student they were recruiting from other districts. Even the school down the street from me or other states. It was very intimidating to know that obviously you're going from big fish, small pond, to very small fish in a very, very large pond. Just not being able to technically be at the same level as everyone else.

Christina felt disadvantaged because her school did not have as many Advanced Placement classes as other schools. Due to this, she was concerned she was going to struggle in her intro engineering courses compared to her peers. Many women, like Tiffany, also discuss their self-concept in the present:

> The technical stuff, I feel super confident in the math portion and my grades would suggest that I'm confident and capable in the academic portion of it, but there's definitely a lot of doubt when it comes to sitting down and doing an assignment. I'll do it and I'll follow my notes and I'll feel really confident and I'll do it again, just to really ingrain that in myself. Then I'll turn it in and I'll just be sort of on edge, like I did the best I could, but I'm not sure if I'm going to get a zero or 100 or somewhere in

> between until I actually get my papers back. I think what I expect is that the insurance comes from just getting my work back and seeing that it's an A or a B or a C or a D or an F, but even with that, I took a class in just like the structures of airplanes and I got an A in it, but even then, I didn't really feel like I knew what I was talking about… I worry that I'm the only person that feels that way and I think it's because of the way that other students carry themselves. They've got a lot of swagger that they bring to it where it's like, "Oh, I did this assignment. I know how this assignment goes. I know what I'm doing."

Tiffany thinks her peers are more confident in their assignments, so her uncertainty makes her doubt her own work. How the women perceive their performance as opposed to their peers creates anxiety. The women in this study made the decision to continue in engineering despite this anxiety.

Agency. The strategic perspectives or actions the women take, or their agentic actions, also continuously affect the women's persistence in engineering. The women used a lot of clichés to describe their agentic perspectives, like Alyssa, "I learned to not give up, to keep going for what I really want to do. Don't let little hiccups trip me up. You learn from making mistakes. One little hiccup here is just going to make you a stronger person in the end, so you can always take away something from that." Alyssa finds some experiences challenging, but she takes on this mindset that she just needs to keep going and she will meet her goal—graduating with a degree in engineering. Meghan takes a similar strategic mindset:

> Because I am a [woman] in the program. I think that for me has been really motivating because I'm a competitive person. I think it's like every time I'm in a situation when I'm faced with something really difficult and I'm like, oh this is so hard. I should just give up and not bother. Then I'm like, no I don't want to be a statistic. I don't want to drop out. I'm going to finish this and it's going to be fine. I think that has kind of led me to have that mindset, that stubbornness.

For Meghan, this strategic mindset to not be a statistic is driven by women's underrepresentation in engineering. Like all the participants, Meghan wants to meet her goal of earning her engineering degree and by changing her thinking, she changes her behavior.

The participants also described the actions they are taking or have taken to meet their goals. Christina gave this example from her past:

> I think I did my own research into it and I said, "Mom, I want to go to this camp. I know we can't afford it, but here's a scholarship application. Can you at least get me some stamps so I can send it out?" She was like, "Yeah." We sent it out. You had to go to this banquet kind of like a week before the camp to see if you got the scholarship. I don't think we were the center focus of that banquet. I think it was just one of the awards they mention. Lo and behold, my sorry butt won. I went to this camp all week. I met a lot of girls. I think what was really inspiring, there's a woman there who was a biomedical engineer. She had successfully become a doctor and now she was becoming a lawyer or something. It was crazy. I was like, "Wow, you're doing three, the big, that's crazy." That was really like wow. There was a lot of girls

> there in college, obviously, that were like, "Yeah, we do this, that, and the other." I was like, "Wow."

Even when she was younger, Christina took a strategic action to meet her goals. While Christina's strategic action turned into an instrumental learning experience (to be discussed in a later section), the participants told stories demonstrating their continuous actions—seeking out and applying for co-ops, research opportunities, or jobs—to meet their goal to become an engineer. For example, Laura is agentic about her future career by networking:

> I keep in touch with my first internship bosses and direct supervisor. And then through [mentor], I of course had my [research team] that I worked in. But I also reached out and asked for connections into the more pharmaceutical sciences and pharmacology groups so I could see their perspective of what type of education they had. What types of career opportunities they have outside their current position and then from there I've been connected with some other people and my mom's friends from college who are in HR, and just happen to go into pharmaceutical sciences. I reach out to them and talk to their different laboratory scientists and what types of roles they've had, and what they plan to do from there because ... So, last week I talked to a woman who would do pharmacology research, but she also has a DVM. So, it's kind of unique to see that perspective.

Laura used her network to find out what steps she needs to take to end up in the job that she wants. Like Laura, had the women not chosen to enact similar strategic perspectives or actions, they might have done so because they were making the decision to leave engineering.

Environment

Another continuous influence on the women's trajectories in engineering is that of the environment, wherein one's life constantly interacts and responds to the environment (Savickas et al., 2009). The environment appears in multiple levels of the LEARN model (Jaeger et al., 2017). Throughout their engineering trajectories, the women find themselves congruent, marginalized, or needing to adapt to the environment.

Congruence. Congruence with the environment means feeling like you belong. Some of the women felt congruent with the environment because there were other people like them in their discipline. For example, Sam felt congruence because she had friends in her field:

> They know exactly what you're going through, even if they're not chemical engineers, but just friends that are engineers. They know what the long nights are like, so with them pushing you to keep going and you being able to talk to them about the same things that you're going through, it really helps versus talking to someone else that's maybe a different major and just doesn't really understand I have five classes and they're all hard. Instead of "Oh, I have this one that's easy." I just think having friends in the field makes it a lot easier.

Having friends who understood the challenges of engineering coursework made Sam feel better. Having friends in engineering made Sam feel a sense of belonging. Also reflecting on congruence, another participant described how her race made it easier for her in engineering:

> White people are the majority here. So, I think it's made a... I have more people I can relate with. My gender, being a woman has allowed me to make connections with other people. I don't really see it as a hindrance or anything, I've never been discriminated against because I was a woman. But, it has allowed me to be in things like women in engineering and women... Just those types of things that aren't really open to... There's not like a men in engineering club or like we have National Society of Black Engineers, but we don't have like National Society of White Engineers. So, I'd say that I'm pretty much the majority... I'm not a minority really in anything besides being a woman, but I don't really see being a woman as a hindrance. I guess I've just had a good experience because I haven't really had to worry about other things that other people might have to worry about. Just not having anyone to connect to. So, I'm from North Carolina. I'm a Christian. I'm a white woman. There's been a lot of people around me that look like me and think like me. So, it's been a more smooth transition, I guess.

This participant thinks that her transition to engineering was easy because the other people in her program were like her. For their own reasons, both women's stories demonstrate feeling like they "fit in." When they felt like they "fit in," deciding to stay in engineering seemed easier. This was not the case for everyone throughout their trajectories, and if women do not feel like they fit it, at what point do they decide to leave?

Adaptation. In line with the model, participants also spoke about the need to adapt as a result of the environment. Joy discussed needing to adapt her behavior while on the job market:

> I don't think that I'm the greatest at like self-promotion. I love to think of humility as like this great thing that people see in you and they love you for it, but that's not true. In doing things like applying for jobs, I've had to wear a hat of self-promotion and doing this, you know, elevator speech to different people. Talking about what I did and each of my experiences, and I have to let go of the emotions that I have associated with them, where they'll be like, "Can you tell me about an experience when ..." Then I have some neatly compartmentalized version of what actually happened, and I tell that to them. I've had to do that, and it does involve partly remembering the technical aspects of what it was that I was doing. Then also seeing good in myself and what I did. I usually just view things as, I did this right, but let's not dwell on that, let's dwell on what I could have done better.

Joy recognizes that although she might not like to "dwell" on her experiences, she needs to become better at self-promotion and reflecting on her work to do well in interviews and secure a job. The women's stories also demonstrated adaptation when they realized that they were not in the right discipline and needed to pursue a different field, like Christina:

> I got in the space camp. I went to Alabama for a week. I met a bunch of people. I realized space isn't something I want to go into, but I liked building the things that could go into space. I don't want to be an astronaut that goes up there. Don't quote

> me on that because if they want to make me an astronaut, sure, let's do it. I'll be Sally Ride, it's all good.

While Christina may not have felt congruent with her environment, she demonstrates a willingness to adapt to her environment in the future for the right opportunity. This adaptation serves as a decision point for Christina to be open to different opportunities in engineering. Had Christina not been willing to keep this opportunity open, her reaction to the environment could have been described as being marginalized.

Marginalization. The last environmental behavior that Jaeger et al. (2017) discuss is marginalization or the feeling that you do not fit your environment. Many of the women told stories demonstrating feelings of marginalization in the first year of their program. For example, Audrey explained:

> Before I switched to industrial I was a mechanical engineer. I was doubtful of whether I'd be able to do it or not, because it just wasn't the way I... Statics is just not the way... I just don't think that way and I've never been good at building things or using tools and stuff like that. So, that scared me. I remember really telling my dad, "I'm not interested in this. I don't want to build these things. I don't know how to use these tools." He was like, "They'll teach you how," but I don't know, even if they teach you how, I still don't think I'd be very good at it. It was very discouraging.

Despite her father's encouragement, Audrey did not feel like she fit her environment. As a result of this marginalization, she made the decision to transition to industrial engineering where she had a better fit. Some of the women also told stories about feeling marginalized professionally. Laura described how different engineering majors at NC State carried different esteems:

> It's a lot harder to get an internship than what they tell you. When we do our engineering ambassador information sessions, we talk about the career opportunities. We have the second largest career fair in the country, first largest on the east coast. We have a lot of companies that come in. They're definitely geared more towards other majors than what I have, so from my perspective, it's much more difficult than someone who's in industrial engineering, where there's several hundred companies coming to the career fair just to recruit them.

Laura felt marginalized because she thought her discipline, biomedical engineering, was not as highly recruited as other disciplines, like industrial engineering. Based on this marginalization, Laura could have decided to pursue a different field—in engineering or even in a different discipline. Like their reflexivity with the environment, the women also make decisions about staying or leaving engineering due to their past determinants.

Past Determinants

In the LEARN Model the past determinants are made up of instrumental learning experiences, schemata, and associative learning experiences (Jaeger et al., 2017). These past events and the women's interpretations of these events affect their engineering trajectory.

Instrumental Learning Experiences. Instrumental learning experiences are those where the women either develop a positive affiliation or aversion to engineering in response to an event. Regarding positive experiences, by using an artifact from her past, a sticker from NASA, Tiffany described how childhood experiences led her to want to be an engineer:

> I was given [this sticker] when I went down to Marshall Space Flight Center in Huntsville, Alabama, 2015. Though it was given to me within the past year, my whole childhood, my whole youth, adolescence was, the goal was to work for NASA and so everything I did, I did with the dreams of working for NASA. I took special courses in high school because I wanted to go work for NASA. I read certain books because I wanted to go work for NASA and so probably without NASA being as dominant in my childhood, I definitely don't think I would be exactly where I am right now and with the same motivations that I have right now. Following my childhood, my father worked for United so I had the opportunity to be around airplanes a lot and airports and so I was like, "Oh, air travel is so cool." Then I moved into just being able to watch TV that was not geared towards children, so away from the PBS specials and Elmo and all that, but I ended up watching documentaries based on the Challenger disaster and the Columbia disaster and to me, those were so tragic because it sort of left a sour taste in everyone's mouth about NASA and what was going on. Then I went and I read into all the Apollo missions and Apollo One and how that really put people off and then how it just became routine and oh, something bad would happen and that's when the public would care about what's going on with NASA and I was like, "Well, NASA is super cool. They're doing a lot of really awesome work and astronauts are putting their lives on the line to be able to go and

> do these amazing things." I was like, "I want to work with them to make this safe." So that we get to care about all the awesome things and we don't have to turn on the TV and see that a space shuttle is not going to make it home okay, because that's really upsetting. I want people to think about NASA and feel good about it and not be like, "Oh, yeah, remember that disaster? And remember this disaster?" Stuff like that. As I've grown up and I've had the opportunity to meet astronauts and to learn more about missions and what goes on at the International Space Station and it becomes more like, okay. I don't necessarily think that I want to be like hands on the jobs doing this in space, but it would be awesome to be able to help someone do this or being able to set someone up for success, or develop tools so that I know that they're safe while they're doing this sort of thing. The point really really hit me when I was in high school, so I'd gone through my childhood of spending a lot of time around airplanes and airports and I was like, "This is cool. I love this."

Tiffany's story does not include just one instrumental learning experience; it includes many, ranging from reading books to meeting astronauts. These instrumental learning experiences had a positive influence on her decision to study engineering.

Besides childhood experiences, many of the participants told stories about professional instrumental learning experiences like Deb. Deb told a story about her co-op at [company],

> I was able to improve the Gel Deodorant filling line, it's efficiency on that line by ten percent, which is something that the [company] staff was kind of mind blown about.

> That's one of the reasons they asked me to come back a second time. So, I definitely got praise for that.

The success and praise that Deb experienced positively impacted her engineering trajectory so that she decided to continue her co-op for a second term.

Unfortunately, the women's instrumental learning experiences were not all positive. Many of the women's negative instrumental learning experiences were attached to classes. For example, Penny questioned staying in engineering because of her experience in Java 2,

> It was a very difficult class, and I actually ended up failing it the first time, had to retake it. But when I was taking it the first time, there was a point where I felt like I was an imposter, and I was just riding off of people's success. And everybody else was helping me code, and I didn't know what I was doing. And this was because I was failing these projects that were just absolutely horrible.

Penny's engineering trajectory could have ended if she gave into this aversion and had made the decision not to retake Java 2. Similarly, Laura explained that she did not like any of her classes her first year:

> I didn't like any of my classes. I did not enjoy a single one of the professors that I had. It's kinda hard in your first year of engineering because you're still not taking engineering classes. We have one E101 course and it's a very high-level overview. You're not necessarily working on a project that relates to your major, so it's hard to see what you might actually be doing with this degree. Because when you're just in a calculus class, or a physics class, it's all theoretical, and that's not necessarily what an

> engineering degree will take you. It's definitely a more hands-on degree. You have to understand the theory in order to get there and it's really difficult to see that within the first couple of classes.

Like Laura, many of the participants mentioned struggling in their first year in the pre-major courses. Again, these negative experiences could have ended the women's engineering trajectory but these participants persisted in the discipline.

Schemata. Also in the past and affecting women's engineering trajectories are schemata, or the hypotheses that are used to interpret societal events. For the participants, schemata were often illustrated in the interpretations of women in engineering, a male dominated field. Sam explained her understanding of work/life balance in engineering:

> I do think that in engineering, sometimes people will put their personal... like as women, their personal goals behind them as far as having children, just because [in] engineering you work a lot of hours. There's really no way around it. I mean, [the field] is known to be for the White male. Now, there are companies that are looking for females. They want a diverse mindset in their company. I think that's changing, but I think it's always gonna be, for women, hard to find that work/life balance between your personal and your work life, just because it's the demand for engineering time wise. It's high. I don't know if that's something that will ever really be able to change, because you can't... as an engineer, you're always on call, you're always needed. It's something that... I don't know if that can be changed.

Notably, Sam indicated an assumption that engineering is a demanding field compared to others. Sam's understanding of women's work/life balance, especially relating to family planning, could have influenced her decision to choose the field of engineering. Sam also alluded to companies wanting to diversify their workforce by hiring more women. Related to these reasons, participants like Deb also talk about interpreting their gender as a benefit in the field:

> I think a lot of the time, it has played in my favor, when it comes to applying for jobs and things like that. I think people get really surprised when they find out you're a woman engineering. And, even in my social experience when I meet new people and they ask me what I'm doing, they get very thrown off about the fact that I'm in engineering because they're like, "Oh you're normal! I wouldn't have guessed that". It's kind of like a double-edged sword, because it's nice that they're surprised in a pleasant way but then at the same time you're kind of offended, like what did you think I'm a bimbo, and so on.

Deb expresses feeling both positively and negatively to the reaction that she's an engineer when there are so few women in engineering, but professionally most of the women in this study believe they have more opportunities because they are different. These schemata, or hypotheses that the women use to interpret societal norms, challenged their decisions to stay in engineering. Based on these assumptions, the women could have easily decided to pursue other fields.

Associative Learning Experiences. The women's past learning that is driven by others in society also affects their decisions regarding engineering. For Penny, these societal influences took the form of a physics teacher:

> I remember telling my physics teacher I was going into aerospace, and he was kind of like... not super encouraging. I don't know. He didn't try to discourage me from it, but he was like "You know there's a lot of people in that field. It's very competitive. You have to be really, really smart." And I'm over here like "But I am really, really smart ..." "I got one of the top grades in your class. Did you forget?"

Penny's teacher introduced doubt about her ability and potentially dissuaded her from pursuing engineering. Tiffany could have also been dissuaded from engineering by what she heard at a conference:

> I was at a conference this past weekend, and it came up. This guy from [technology company] was like, "Well some women don't want to have a family or get married because they know that might slow down their career progression." My idea is that if a company provides you with the opportunity to have a child and provides you that maternity or paternity leave, you should take that.

Tiffany challenged what she heard and took a different perspective on this associative learning experience. Tiffany could have decided to not pursue engineering anymore because, according to this guy, the field is not supportive of women having a family.

Learning

In the LEARN Model (Jaeger et al., 2017), women learned from their past determinants, which influenced their present determinants. The participants mentioned the learning and reflection they underwent to select their field of study or area of focus. For Kelley, she learned that she did not want to be a nuclear engineer, but she did so by trying a lot of things:

> Probably the end of my sophomore year in college is when I really was doubting if I was cut out to be an engineer. I was like, "Maybe I should pursue something else," and I'm like, "I don't know what else I would pursue."; I've figured this out that I wanted to pursue engineering for a really long time now even before I put the name engineering too…. I went through quite the list. Navy Nuke is a really big part of nuclear engineering. It's working on the submarines, working on aircraft carriers and things like that. I had already ruled that out. I'm really not a military personality. I don't think I would succeed there. I think I'd be really nervous and not happy. That one was ruled out really early on. I did research as an undergrad that year of my sophomore year with radiation detection. A lot of it will go into security like national security. How do you detect if other countries have nuclear materials but then also more locally, in the airport, they will screen for radiation. They're always improving the technology of that screening. I did a little bit of research with that. It just really puts that fear into you where you're like, "I'm always thinking about who has nuclear materials."; I didn't really want to constantly be thinking about that. It's important to

> realize and rationalize but I'm like, "Doing this 24/7 would just really stress me out."; I don't really like that. People, most people from our department will go into power operations so at a power plant.

As a result of these instrumental learning experiences, Kelley learned about herself, which helped her make decisions about what she wanted to do instead of nuclear engineering. Similarly, Tiffany described learning from past determinants from earlier in her life:

> From the time that I was 12 years old to going through high school, I figured out that I was pretty skilled in math and science and so like, up until then you take all your courses the same, I guess in elementary and middle school and you don't necessarily have an affinity for anything, because you're all learning at the exact same rate the same sort of things, but once we got into having options and I was really succeeding in math and science it was like oh, this is awesome. So, I put together, I think planes are great and I want to go to MIT and I want to work for NASA and it turns it out I'm not so bad at math and science. I was like, "Oh, what can I do with all this? Engineering." It was like I had decided what I was going to do before I knew how I was going to do it, and so engineering was the last piece of the puzzle that was like "Oh, of course." and then I started looking into engineering programs and I was like "Brilliant."

Many of the participants, like Tiffany, learned they were good at math and science when they were younger. This set them on the path to continue to engage in math and science activities, whereas, if they had learned that they were not good at math and science, they might have decided to pursue another field instead. The participants' narratives suggest that learning from past determinants directly affects what the women do in the present and future.

Present Determinants

Present determinants pertain to women's goal representations, self-efficacy and self-assessments, and outcome expectations (Jaeger et al., 2017). In this way, how well the women assess their competencies affects what goals they set for themselves and what outcomes they can realistically expect based on their behaviors.

Goal Representations. The goals the women aspire to are their goal representations. The participants, all nearing graduation, all spoke about their professional goals. For example, Meghan identified her short-term and long-term goals:

> I'm hoping that by working at NASA that I can maybe get on a project that's being researched with the university and then start grad school in the fall. Then long-term goals I guess are to be working at some kind of research lab when I get out which is what I brought for the future thing.

Since the women are all close to graduation, they have specific ideas, like Meghan, about what they would like to do next. Some participants were more reflective of goals for their professional experience as opposed to a specific employment position. Deb reflected:

> My major goal is definitely to find a job where I can constantly develop and grow as a professional. I think my biggest fear is definitely being stagnant somewhere. I've had too many friends that have found jobs where they're like, well I kind of do the same task every day and I'm not really developing or growing or learning. That's

> something that I would definitely like to avoid. I would prefer to go into a job where I'm challenged, that constantly has different situations and different scenarios that I learn from and I can gain different skills from, whether it's people skills or technical skills. I think my ultimate goal would just being able to reach my fullest potential. I would hate to look back and say, oh well if I'd have done this, I might have been here.

Deb, like many of the participants, was in the process of interviewing, and with multiple job offers in her preferred field, she set goals that are more closely attributed to experience. The women made goals to keep them on engineering trajectories, but they could have easily made the decision to make goals that took them off of it. Different women that decided to leave engineering may have an alternate perspective to bare.

Self-Efficacy and Self Assessments. Another present determinant, self-efficacy, pertains to one's assessment of one's ability in a domain (Lent, Brown, & Hackett, 1994). In their interviews, the women were asked how they consider their engineering ability. For example, Penny assessed herself quite highly,

> I'd say about a solid 9 out of 10. Have a great GPA. I'm on good relations with most of my faculty. Most of my professors know me. They've written me some killer recommendation letters. I understand the material. I can apply it. I can help other people apply it, but there's still sometimes things that I get tripped up on. So, not perfect, but I'm definitely up there.

Like Penny, most of the participants assessed themselves highly in regard to their coursework, but the women were less confident in their abilities entering the workforce. Audrey provided an example:

> When I think about my engineering ability I think about it in the real world, like out in the job. And so far my internships, I feel like I haven't done... They're pretty challenging because I didn't know what I was doing. So, I feel like I have kind of bad engineering ability, because I'm good at doing the tests and getting good grades. But when it comes time to face a real world complex problem it's kind of hard for me to like... I don't know, I feel like I'm not good at that.

Many of the participants are unsure of their competencies as they pertain to the “real world.” Since they do not feel that they are ready for what they want to do after earning their Bachelor’s degree, some participants planned to pursue further education like Meghan:

> I think now I'm pretty confident in my ability just seeing how much my work has been rewarded through the jobs that I've gotten. It makes me feel really, I guess like a checklist of okay, I put in all this effort and now I have a job at NASA. It was worth it kind of thing. I think now about to graduate I do feel like really happy with my experience in school but also on the other hand part of the reason I wanted to go to grad school is that there's so much that I don't know. Over the summer looking at the National Lab, everybody there has a PhD and just listening to them talk for ten minutes it's like wow, this person knows so much about this topic. I didn't even know what I didn't know kind of thing.

Like Meghan, a self-assessment—that she needs to learn more—influenced her goals and decisions about her future. Other women, feeling unprepared for the engineering workforce, may make the decision to enter another field instead.

Outcome Expectations. Whereas self-efficacy relates to how well one could do something, outcome expectations demonstrate what one thinks will happen based on a current behavior (Lent, Brown, & Hackett, 1994). Like Meghan, other participants discussed their plans to pursue further education, and by pursuing further education they expect a particular outcome. Audrey explained:

> Well, after graduation I'm doing the Masters of Analytics Program at NC State. I just got accepted last week. It's 10 months. I graduate from undergrad in this May of 2017 and then I start the Analytics in June in summer two session and then it ends in May 2018. It's only a year. In case I didn't get into my Analytics program, I also applied to [consulting company]. I went to their [consulting company] program, because I got hired into the Washington D.C. Office. I went up there on Thursday and Friday to see what it was all about. And I loved it and I really want to work there after Analytics. And it works out because they do hire a lot of people from Analytics every year. Well, they're not deferring it but it's kind of a good thing because you end up getting paid a lot more if you go to Analytics. I don't think it'll be a problem to get an offer again, just based on what I've heard.

Audrey applied to an employment position and a Master's in Analytics Program and she was accepted for both, but because she planned to do the Master's in Analytics Program, she also expected to get a better job offer from the same company. Laura also planned to pursue further education, which will result in specific career opportunities:

> My goal is to not do a post doc and go straight into industry, but a lot of the job descriptions require that you have a PhD. Two years as a postdoc and then you can be eligible to apply for said position but I have no interest in doing a postdoc because most of them at this point in time, maybe it'll change by the time I graduate, are academic focused. Very few companies have industrial postdoc work experiences. I'd definitely be interested in doing an industrial postdoc but I don't want to go back into academia and work in a lab cause that doesn't pay well. I think it's more so just for the hands-on experience of getting, I don't know why you would need more experience after you've spent five years in a PhD program doing research. They want more experience. Designing experience, analyzing results yourself, and the writing of course.

Laura recognized that pursuing a PhD will not be enough for her desired career and, while she might not be happy about it, she will need to complete a postdoc to qualify for her desired role. If the women do not think they can obtain their desired outcome in engineering, they may make a decision to pursue a different field. These present determinants taken together lead women to make decisions about their future engineering trajectory.

Decision

Throughout their stories, the women identified situations or opportunities where they made decisions to stay in engineering or do something engineering related, sometimes without knowing it. Other times, the women were much more cognizant of their decision-making processes. Kelley described transferring from nuclear to industrial engineering after eventually deciding that nuclear engineering was not for her:

> "I don't really want to be a nuclear engineer."; I really like people. I really like problems that involve people. Even when I started industrial, I really thought I was still going to be in the nuclear industry. I thought that I would be able to go to grad school for human factors, hopefully redesign control rooms and things like that. Now, I guess my goals have changed because I've been able to experience different ways that make me happy. I like to be in charge. I like to have a group of people and I like to challenge them and just see how they work together.

Kelley learned from her experiences and made decisions about what she wanted to do, which was not nuclear engineering. The participants' decision-making about their engineering trajectory was not only about their specific engineering majors but also, at the end of their degrees, their future employment roles. Joy explained:

> I just applied to a wide variety of things when I was applying to jobs. That results in the unique challenge of, if you don't narrow your goals before applying, then you have to narrow them afterwards. For instance, now I have two offers and they're in different roles and I have to decide which one I would like better.

Joy was fortunate to have two job opportunities to choose from, but based on her work to seek out and apply for these jobs, she then had to make a decision about her future career outcome. While every component of the LEARN model identifies a decision point for the women, Jaeger et al. (2017) identify the connection between present determinants and future career outcomes is a “decision”.

Future Career Outcome

The final sequential box in the LEARN Model is the future career outcome box (Jaeger et al., 2017). Within the future career outcome box is role expectations, or what role(s) one envisions for herself.

Role Expectations. Role expectations pertain to all our potential roles in life—both social and professional—and how these roles interact with one another (Super, 1980). Again, since the participants in this study are at the end of their academic careers and ready to graduate, they spoke about their future professional roles and what they expect from these positions. Alyssa has already accepted a position with [company], and she brought a brochure to her interview as an artifact to discuss her future role:

> My future is based around this little [company] brochure. It's just talking about the program for the [Leadership Program]. There's a guy in there, [guy], who is highlighted and it kind of shows his path, that he was taking and how long it took him to become a plant manager. I think that's something that's really exciting and something that I really connected to, with him about when I got to talk with him. Just asking him, "Did you really see yourself as a manager or is it something that just kind of came to you one day?" He's like, "Yeah. It definitely, it's not something that I thought I was going to do when I was first starting out, but after getting the feel for it and realizing that it's something that I really like to do, I just went for it." It seems

> like a long time, but considering that a lot of engineers are in their jobs for 40 and 50 years, I think 15 years is a pretty good time span to become a plant manager. past I want to be more than just a small engineer doing small engineering projects. I want to work on something big.

Alyssa has decided to accept a position with [company] and now she’s excited about her professional role with it and the opportunity to participate in its [Leadership Program] to help her move up the ranks to become a plant manager. Tiffany also brought a brochure as an artifact to discuss her future; however, Tiffany is weighing what different roles she might have as opposed to what she expects to have:

> I brought a [service organization] pamphlet that was handed to me when I talked to one of the [service organization members]. It's a two-year program and they pay you while you're away, so your housing is taken care of, your meals are taken care of, making sure you're not going to die from Tetanus. That's all taken care of but you're also making money while that's happening so you're serving. I'm putting forth my engineering knowledge. I can help teach math classes. I can help teach engineering courses. I can help build something, part of like [other service organization]. While that's happening, I'm getting paid so that at the end of two years, I can go and pay off my loans and then I won't have to care about that and there's an opportunity for them to help me go to masters to graduate school if I want to do that.

While Tiffany is less sure of her future role than Alyssa, she is keen on a potential role with [service organization] and what that might entail. The women's role expectations are a clear reflection of whether they made the decision to remain on an engineering trajectory.

Implications for Theory

The purpose of this narrative study was to explore whether Jaeger et al.'s (2017) LEARN Model could be used to understand the learning and career-seeking experiences and trajectories of undergraduate women graduating with degrees in engineering from a Southern, top-tier research, predominately White institution. As shown by the previous section, many of the women's stories in this study did map onto the LEARN model. For example, Christina described her continuous personal determinants—her agency through applications to scholarships for camp and her agentic perspective that she could do anything that she put her mind to, her past determinants—or the instrumental learning experiences of attending said camps, learning what she did or did not like from those experiences, which informed her present determinants—her goal to earn her degree in nuclear engineering, her own self-assessment of her work in nuclear engineering and what she expects from her efforts, and, ultimately, her future role expectations—what she understands and expects of her post-graduation employment position. Similarly, Penny spoke about feeling like an imposter because she thought she was riding everyone's coattails (self-concept, continuous personal determinant), how the experience of failing Java 2 made her not want to continue with computer science until she had a powerful conversation with a faculty member who managed to convince her that everyone felt like an imposter (instrumental learning experience, past determinant), from that experience she learned that she could persist in computer science, she then assessed her performance very highly—a nine out of ten (self-efficacy and self-assessments, present determinants), and, based on this, she decided to pursue her Ph.D (decision), and had expectations about what she will do during and after her Ph.D program (future role expectations). Like the other study participants, the women continuously made decisions about whether to stay in engineering and, from their stories, could have very easily decided to take a different path at many points. Nevertheless, there are a few areas where the LEARN model did not address the participants' stories, and later these will be illustrated to make the case for some updates to the model.

What did the LEARN model do well?

First, three areas of the LEARN Model that were especially applicable to the undergraduate women's storied experiences were identity, instrumental learning experiences, and role expectations. As for identity, Jaeger et al. (2017) take care to distinguish between socio-cultural and science identities. The participants' socio-cultural identities as women were very much relevant in their stories, for some, they liked being "unique" in their degree program, or they wanted to be a trendsetter and lead the way for more women into their field. Other women struggled with their identities in that they did not feel a sense-of-belonging when no one else was like them. As for science identity, the women told stories about how they constantly engineered things in their heads, "thinking like an engineer", which made them self-identify as an engineer. According to Carlone and Johnson (2007), self-recognition is only one part of science identity, the other part is recognition from others. The women told stories from their past where outsiders had indicated that they may or may not do well in engineering. Taken together, the women were continuously negotiating their identities—both sociocultural and science—to determine if they were congruent with their environment. This negotiation influenced their decision to stay or depart from an engineering trajectory.

The second area that fit well with the participants' narratives were their past determinants, specifically their instrumental learning experiences. This is an effective bucket to capture all the events that happen in one's life that can contribute to a decision to stay or leave engineering. Unlike the "leaky pipeline," which focuses on transition points, the LEARN model shows that it is not just when women transition from one stage to another, like from high school to college, that they decide on their engineering trajectories. Instead, any event—a book a woman reads, a camp she participated in, something that a recruiter told her, a female CEO of a technology firm not taking maternity leave, a life-affirming writing class that she took, etc.—can all influence a woman's decision to stay or leave engineering. The social learning theory of career decision-making (SLTCDM), indicates that learning experiences—both direct and indirect—drive one's beliefs and actions. Due to this, Jaeger et al. (2017) distinguish between instrumental learning experiences, associative learning experiences, and schemata. While the distinction seems important, the undergraduate women in this study described instrumental learning experiences more than the other two past determinants. Perhaps in a few years, with more distance from the program and more opportunity for reflection, this would change.

A third area where Jaeger et al.'s (2017) LEARN model was particularly relevant to the participants' stories was the women's role expectations. At the end of their undergraduate careers, the women were applying to or had already accepted jobs or opportunities for further education. Nevertheless, the women had very clear ideas about what they expected from their future roles including whether they would afford an opportunity for the social life to which they aspired. Super (1980) indicates that role expectations can be both what an individual envisions for her roles and what outsiders also expect about the individual's performance in said role. The participants in this study emphasized their own role expectations and scarcely mentioned any that others might have for the participants. While these three areas—identity, instrumental learning experiences, and role expectations—were very clearly demonstrated in the participants stories, there were a few things that the participants discussed, which were not easily placed in the LEARN model.

How could the LEARN model be improved?

Two items that were important in the participants stories, but did not find a place of equal significance in Jaeger et al.'s (2017) LEARN model, were the people and resources, which influenced the women's engineering trajectories. The parents, relatives, friends, teachers, mentors that supported or challenged the women's decisions to stay in engineering could fit a few areas. For example, Sam, Kelley, and Audrey all had fathers who were engineers. Because of this relationship, these women had several instrumental learning experiences with their fathers. These women also discussed the challenges of engineering with their fathers and, due to this, could ascertain a sense of congruence with their environments. Perhaps this paternal relationship also feeds into the women's identities—but are these classifications enough? Do these areas sufficiently address the influence of others on the women's engineering trajectories? Similarly, Sam, Kelley, and Audrey likely had access to many resources that others did not. While Christina was agentic in her decision to pursue engineering, despite the resources unavailable to her, other women might not know what they are missing. Given the strong influence of others in our lives, in future iterations of the LEARN Model, more attention is needed to help distinguish where others might continuously interact with a women's STEM trajectory. Further, given the emphasis on what is missing from a woman's experience which can be attributed to her not participating in STEM, Jaeger et al. (2017) might better describe how it is not only the way that women interact with their environments that is important but also how they do not.

Beyond these components, there are a few additional areas where the model could be applied to the participants' storied experiences but further attention is needed. Primarily, the model is cyclical, so many of these stories extend beyond one timepoint. Further, as soon as something happens in our present, it becomes our past. This introduces confusion between the past determinants versus the present determinants. The present determinants might be better attributed to continuous personal determinants. For example, the women have had goals in the past and will continue to have goals in the future. Self-efficacy (Lent, Brown, & Hackett, 1994), the assessment of one's ability in a domain, is similar to self-concept (Espinosa, 2008; Sax, 1994a; Sax, 1994b; Sax et al., 2015), the consideration of one's abilities in STEM compared to her peers, in that they both happen continuously. The expectations, because of one's efforts, also extend beyond one-time period. The same should be said about one's interaction with her environment. A woman's sense of congruence, adaptation or marginalization not only informs her learning, but also informs her past experiences and her future. This means that Jaeger et al.'s (2017) single arrow from the future career outcomes box to the learning arrow is misleading.

One final critical piece of the model that is misleading is the use of "decision" as one arrow from the present determinants to the future career outcomes. As demonstrated by the participants stories, every component of this model is an opportunity for women to make a decision to stay or leave a STEM trajectory. In the very least, Jaeger et al. (2017) should rename this arrow "choice" to not over emphasize a single decision point. Or, based on these participants' stories, the authors might consider updating the LEARN model to resemble something like Figure 2.8.

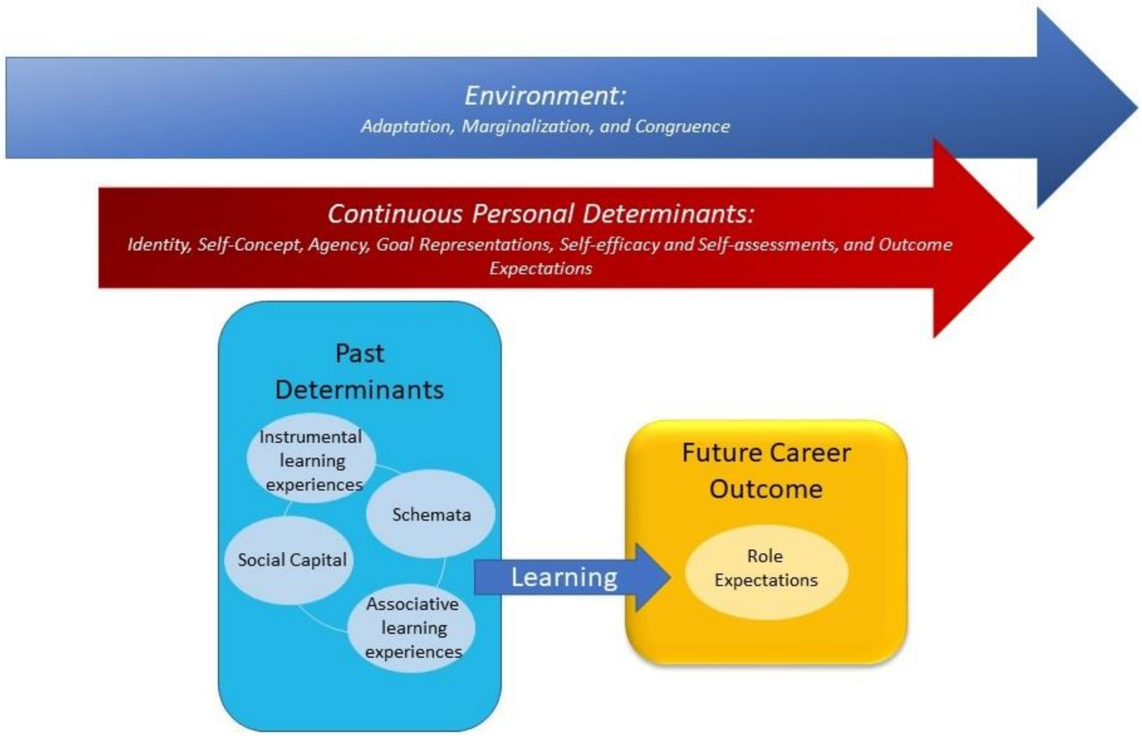

Figure 2.8. The New Life Experiences and Role Negotiations (LEARN) Model for Female Undergraduate Engineering Students.

In Figure 2.8 the environment has been moved to cover a women's entire trajectory, which more appropriately demonstrates her negotiation with the environment throughout her life. What Jaeger et al. (2017) referred to as "present determinants" has been relocated to continuous personal determinants because goal representations, self-efficacy and self-assessments, and outcome expectations can also exist in the past and future. Then, a circle for social capital has been added to the past determinants to indicate the role people and resources play in the women's experiences. Finally, any reference to "decision" has been removed to emphasize that all these instances represent an opportunity where a woman might make the decision to stay in or leave engineering.

Implications for Research and Practice

The above section discussed implications for theory while this section includes implications for future research and practice. The participants in this study are women who made the decision to pursue a degree in engineering. This is only half of the story. To truly explore whether the LEARN model fits undergraduate women's trajectories in engineering, and their decisions to leave or stay, the storied experiences of women who decided to pursue another field would also need exploration. The women in this study had experiences where they could have easily made the decision to leave engineering. What really is the difference between women who made a decision to stay in an engineering trajectory versus the women who made the decision to leave it? This opportunity is an implication for future research.

Other opportunities for future research are to see if the assumptions of the model hold for other women in STEM. For example, do the assumptions of the model hold for these 11 women later in life. Jaeger et al. (2017) initially intended this model for STEM doctorates, so can the model also explain the experiences of engineering doctorates? Or, can the LEARN model be used to explain the experiences in other STEM fields—especially fields with lower levels of female representation like physics or computer science. At NC State, computer science is a part of the College of Engineering, so a computer scientist was included as a participant in this study, but at other colleges and universities it is not.

Regarding implications for practice, one thing the LEARN model does well is showcase the unique experiences of all women. The 11 participants in this study had varied identities, past determinants, interactions with the environment, and future career outcomes.

Due to this, engineering programs could benefit from a cultural and symbolic shift to be more flexible. Students should be able to see that engineering can fit them, whatever their identities and whatever they want to do as opposed to the student having to fit into a rigid engineering “pipeline”. This could take the form of better marketing to showcase many different engineering trajectories or even loosening requirements to allow engineering students more flexibility with their coursework.

Where the women’s stories sounded the most similar was regarding their self-assessments, self-efficacy, and self-concept. As a result, another implication for practice from this study is the need for greater efforts to build women up so that they can feel more confident in their abilities. This means women need more affirmation from their faculty and their advisors that they are doing well and are fully capable of becoming an engineer. This is a departure from the “weed out” culture of many early engineering courses, where women—and likely men, too—feel that they are not doing well. This is not to say that everyone should get an “A”. Rather, it is increasing one-on-one conversations to put students’ expectations and performance into perspective so that people do not depart engineering because they think they are doing poorly when they are not.

A final implication for practice from this study pertains to training faculty, teaching assistants, and staff to understand the importance of their role in the experiences of women in engineering. These trainings could involve role playing and storytelling to demonstrate how instrumental learning experiences, experiences where women develop an aversion or an affinity to STEM, play a critical role in women’s decisions to persist in engineering.

Previous research identifies social cognitive factors, or even a “chilly climate” as reasons why women are not retained in STEM fields; however, concepts like these let faculty, teaching assistants, and staff off the hook. Experiences and interactions—for example, a negative experience in a study session or a good day in the research lab— matter, and these folks should begin to question whether their actions will cause a student to have an affinity or an aversion to engineering. If it is that later, then they need to do something else.

Conclusion

The purpose of this narrative study was to explore whether Jaeger et al.’s (2017) LEARN Model could be used to explain the learning and career-seeking experiences and trajectories of undergraduate women graduating with degrees in engineering from a Southern, top-tier research, predominately White institution. The women’s stories about their engineering experiences did fit the different components of the LEARN model, emphasizing that women can make a decision to stay or leave engineering for a number of reasons, and these decisions do not only happen at transition points. If their journeys were a pipeline, there would be 11 different pipes. Based on the storied experiences of these women, adjustments or clarifications are also suggested for future iterations of the LEARN model, especially if it is to be used to consider the experiences of undergraduates. In the end, with the underrepresentation of women in engineering, it is easy to assume that women deciding to depart engineering is a bad thing, but women making decisions that are best for them is never a bad thing (Miller & Wai, 2015). Rather, it is the negatives associated with their experiences which drive them to decide to leave which are bad. These negatives are the things that need to be fixed, not women's decisions.

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IS THEORY NEEDED TO EXPLORE THE NARRATIVES OF UNDERGRADUATE WOMEN IN ENGINEERING AT A PWI?

Despite efforts over the last 35 years to increase women in engineering (Gill, Sharp, Mills, & Franzway, 2008), and the knowledge that women play a critical role in the field (Margolis & Fisher, 2003), by making engineering fields more competitive, healthy, and inclusive of all society (Blickenstaff, 2005; Hill, Corbett, & St Rose, 2010; Shapiro & Sax, 2011), women continue to remain underrepresented. Interest in engineering has increased since 2007, however, the gap between women and men in engineering continues to widen (Sax et. al, 2014). The persistent inability to close this gap, despite efforts by multiple organizations and entities, presents an opportunity to reconsider how we approach studies of undergraduate women in engineering. As a first step toward offering an alternate approach, this paper considers the use of theory in qualitative studies of undergraduate women in engineering. When current research efforts have not advanced the field or improved women's experiences enough to stay in engineering, then perhaps the experiences of undergraduate women in engineering need to be evaluated differently.

To fully understand the experiences of undergraduate women in engineering, since previous research seems to miss the mark in reversing their underrepresentation, these women should be afforded the opportunity to tell us their own stories. In a constructivist research approach, different individuals have different realities, which are constructed through their own experiences and interactions with others (Creswell, 2013). In addition, not only do individuals have different realities, these different realities are all equally valid

(Crotty, 1998). Highlighting the different realities of individuals through qualitative research helps to identify the route of women's underrepresentation in engineering. A qualitative research design creates an opportunity to consider a participant's entire experience, allowing her to make her own meaning from her experiences (Merriam & Tisdell, 2015; Patton, 1990). Through iterative designs, it also generates nuanced data which demonstrates the context of said experiences (Namey & Trotter, 2014), helping to further expose and address the underlying causes for women's underrepresentation in engineering.

Suggestions for the use of theory in qualitative research vary. Jones, Torres, and Arminio (2013) suggest that good qualitative research does not necessarily need to be guided by theory. The use of theory should be determined by, "the question of interest, the researcher's personal worldview, and what societal issues influence the phenomenon" (Jones, Torres, & Arminio, 2013, p. 67). However, others suggest that higher education qualitative studies need to be grounded in theory to advance the field of higher education (Orton, 1997; Suddaby, 2006). Beddoes and Borrego (2011) find the use of theory critical to advancing the field of engineering education whereby the use of theory prevents researchers from "re-inventing the wheel": "as theory is intended to be transferable it is a potentially important link between engineering educators and gender studies scholars, thus promoting interdisciplinary scholarship in the complex research topic of women in engineering" (p. 283). Questions also arise as to the "blinders" one creates by using theory, preventing a thorough understanding as opposed to what the theoretical lens allows us to see. In sum, theory can help situate research in a larger body of literature and create consistency throughout a study (from research questions to data collection and data analysis), but it can also lead to poor research design decisions (Jones et al., 2013). For example, some higher education researchers use theoretical perspectives like critical race theory as their methodology; however, critical race theory is derived from legal studies, which makes its application as a methodology in a different field a bit muddy (Jones et al., 2013).

The purpose of this paper is to investigate the utility of a theoretical lens in exploring the storied experiences of undergraduate women graduating with a degree in engineering from a predominately White research institution. The study is guided by two questions. First, how is theory being used in recent higher education research to understand the experiences of undergraduate women in engineering? Second, does using a theory throughout the design of a study affect the shared narratives of these women or a researcher's analysis of them? To address these questions, this paper has three parts: in part one, the use of theory in studies of undergraduate engineering women is explored to understand the importance of theory to this field; in part two, two parts of a qualitative study—one part driven by theory and one part not—are compared in order to determine if engineering undergraduate women's narratives differ when theory is central to the study's design; and, finally, part three of this paper draws conclusions regarding the results of the comparison (part two) and how these results fit into the use of theory in the field (part one).

Part 1: Theory

To understand how theory is used to study undergraduate women in engineering, first, due to inconsistencies in the field, what is a "theory" needs to be clarified. Reeves, Albert, Kuper, and Hodges (2008) explain, “theories give researchers different ‘lenses’ through which to look at complicated problems and social issues, focusing their attention on different aspects of the data and providing a framework within which to conduct their analysis” (p. 631). Essentially, theories help make sense of data and explain phenomena (Strauss & Corbin, 1998; Davies & Devlin, 2010). Yet, with such a straightforward concept, researchers interchange terms like theory, theoretical perspective, theoretical framework, theoretical model, or theoretical construct, which leads to confusion regarding the use of theory.

Jaeger et al. (2013) delineate a theoretical perspective as an “overarching philosophical paradigm, [influencing] how [one] sees the world” (p. 12), while a theoretical framework is influenced by one’s theoretical perspective but it is also informed by existing literature and theory. Sutton and Staw (1995) present a comprehensive list about what is not theory to make clear what is a theory. For Sutton and Staw (1995), referencing relevant theories is important, but just mentioning a theory is not enough. The theory needs to be analyzed and applied to a study. If it is not, then it might be a “smoke screen to hide the absence of theory” (Sutton & Staw, 1995, p. 373). Second, empirical evidence is not theory. Rather, empirical results can be used to support a theory, wherein data are used to develop explanations why something is happening (Glaser & Strauss, 1967). Third, a theory is not a catalog of variables or constructs (even if the variables are labeled theoretical constructs). Again, like empirical data by itself, a list of variables does not explain “why.” Fourth, according to Sutton and Staw (1995), diagrams or models are not theory. Sutton and Staw (1995) explain, “regardless of their merits, diagrams and findings should be considered as stage props rather than the performance itself" (Sutton & Staw, 1995, p. 376). The authors maintain that only written text can fully appreciate the nuanced, causal relationships between constructs. And finally, fifth, predictions are not theory because predictions, or hypotheses, are an indication as to what is expected to occur (or not occur), which still omits the "why". This "why" is the key component to identifying theory. Theory explains *why* evidence and/or constructs lead to a phenomenon of interest.

Beyond what is a theory, scholars have also debated how and when theory should be used, especially in qualitative research. Some believe theory is grounded or emergent from the data (Glaser & Strauss, 1967). Andersen and Kragh (2010) detail the dangers of, "locking our analytical focus and [blinding ourselves] from imaginative theorizing and from revealing new insights and theoretical breakthroughs" (p. 49), where "preordained theoretical perspectives or propositions may bias and limit the findings (Eisenhardt, 1989, p. 536). Andersen and Kragh (2010) also suggest that using existing theoretical research can be likened to "testing canons of positivist research" (p. 49), limiting innovation and advances in the field. To these authors, and others of a similar mind, starting a qualitative study with a theory may stiffen the study and limit overall advances in higher education research.

In contrast, others argue that not using theory from the beginning of a study may result in a replication of efforts, causing the same study to be done again or not advanced (Orton, 1997; Suddaby, 2006). Some scholars also believe a lack of consistent integration of theory is detrimental to the field of qualitative research (Anfara & Mertz, 2006; Bradbury-Jones, Taylor, & Herber, 2014). Pasque, Carducci, Kuntz, and Gildersleeve (2012) explain these scholars' argument is that making educational research generalizable and replicable, as is the case for quantitative approaches, creates legitimacy in the field. Others, like Jackson and Mazzei (2013) think a true answer lies somewhere in the middle—that using theory to drive design leads to, "mechanistic coding, reducing data to themes, and writing up transparent narratives that do little to critique the complexities of social life," and not using it, and letting the voices "speak for themselves," then chunking the data to interpret without context is also problematic (p. 261). As a result, Jackson and Mazzei (2013) propose to "think with theory," where thinking influences design decisions but does not drive them. In this sense, to Jackson and Mazzei (2013), theory is necessary because, while it does not directly impact the design of a given study, it helps guide a researcher's thought processes.

The use of theory is largely influenced by ontological and epistemological beliefs—one's nature or reality and relationship with what is being researched, which together or independently affect research design decisions (Anfara & Mertz, 2006; Bradbury-Jones, Taylor & Herber, 2014; Creswell, 2007; Denzin & Lincoln, 2005; Meyer & Ward, 2014; Van Maanen, Sørensen, & Mitchell, 2007). Of the textbook relationship between methods and theory, Van Maanen, Sørensen, and Mitchell (2007) write:

> Methods generate meaningful data used to test, in weak form, the plausibility of theories or, in strong form, the validity of theories given modest to severe boundary constraints (e.g., Blalock, 1969; Bryman, 1989; Dubin, 1978; Yin, 2002). As an ideal representation, the interplay of theory and data is not problematic but follows a prescribed—almost magical—sequence. In conventional form, problems are

> identified that are of interest to an identifiable research community (perhaps more than one), specific research questions or hypotheses are posed that rest on the theoretical resources those in the research community possess (or seek), appropriate research strategies based on either or both deductive or inductive logic are then spelled out, qualitative or quantitative measures are chosen and put to work, data compilation and analysis then follow, and, with pluck and luck, plausible (or verifiable) inferences and conclusions result. End of story.

To Van Maanen, Sørensen, and Mitchell (2007), theory is integrated throughout a study—research questions relate to theory, data collection and analysis seeks to answer these questions, which lead then to study conclusions that connect back to the theory driving the research questions. Following this "textbook" example of the use of theory, how are theories currently being used in studies on undergraduate women in engineering? Understanding how current research utilizes theory will provide context for the discussion in part three of this paper where the two-part narrative study (part-two) is compared to the field.

Meta Literature Review Approach

To address how theory has been used to study undergraduate women in engineering, this paper follows the work of Greenhalgh et al. (2005) and Kanny, Sax, and Riggers-Piehl (2014) to develop a meta-analysis of literature. A meta literature review affords a robust, systematic analysis of the literature to understand the scope to which peer reviewed articles mention a topic. To conduct a meta literature review, first Greenhalgh et al. (2005) and Kanny et al. (2014) indicate that inclusion criteria and search methods are defined to set quality standards against which research can be judged. For the purposes of this paper, articles were sought via Summon, a library search engine which includes over 2 billion items (books, articles, conference proceedings, theses and dissertations, videos, music, images, manuscripts, etc.). Through summon, the search was conducted using three terms "engineer*", "women", and "undergraduate," and results were limited to peer reviewed articles published between 2007-2017. With these parameters, this search produced 478 results. Next, the abstracts of the articles were reviewed to determine their relevance (Kanny, Sax, & Riggers-Piehl, 2014). To be included in this analysis, an article's abstract had to describe a study on undergraduate women in engineering or STEM in the United States. If the abstract mentioned differences by gender or sex, it was also included for further consideration. After this abstract review, 64 search results remained relevant. Examples of ineligible articles included studies focused on graduate students, faculty, engineering professionals, or undergraduates in other countries.

After determining the relevant articles, the content of each article was then evaluated to consider its use of theory. This analysis of literature used Bradbury-Jones et al. (2014) "levels of theoretical visibility typology" (p. 137) on top of Sutton and Staw's (1995) definition of theory. Bradbury-Jones et al.'s (2014) typology has five levels of theoretical visibility: level 1: seemingly absent (no theory is included in the study); level 2: implied (theory is referenced but not explicitly linked to study); level 3: partially applied (research design is informed by theory, but findings are not applied or interpreted through theoretical lens); level 4: retrospectively applied (theory is used only to interpret findings, and might be included as an afterthought); level 5: consistently applied (theory can be traced through entire article and research process—from design to interpretation of findings). In sum, after articles met the eligibility criterion for analysis (mention of undergraduate women in engineering in their abstract), the articles were subjected to this layered analysis: Sutton and Staw's (1995) definition of a theory and Bradbury-Jones et al.'s (2014) typology.

Theory in the study of undergraduate women in engineering

Of the articles that remained eligible after the abstract review, upon further inspection, only 28 of the 64 articles (44%) used theory at a level 5, where the theory was consistently applied (theory can be traced throughout the entire article and research process—from design to interpretation of findings) (Bradbury-Jones et al., 2014). Of these 28 articles, 20 utilize quantitative methods, five use mixed methods, two use qualitative methods, and one is a meta-literature review. At first glance, this evidence from the field suggests that a constant use of theory is not necessary for publication—especially in qualitative research.

Of the 28 articles at a level five, their theoretical constructs fit three overarching concepts: confidence in ability, leading to a sense of belonging, and identity. While the following descriptions do not critique these 28 articles, they do demonstrate how, in the last ten years, theory has been used to consider the experiences of undergraduate women in engineering or STEM fields.

Confidence in Ability. In the last decade, the most popular theory in peer reviewed studies on undergraduate women in engineering is self-efficacy. Self-efficacy is one's belief in his/her capabilities to reach an outcome (Bandura, 1986). By itself, self-efficacy theory is used four different ways to consider the experiences of undergraduate women in engineering: 1) to compare women and men's self-efficacy levels (see: Concannon & Barrow, 2010; Concannon & Barrow, 2012); 2) to measure difference in self-efficacy between different types of women (see: Talley & Martinez Ortiz, 2017); 3) to measure changes in self-efficacy after an intervention or experiment (see: Marra, Rodgers, Shen, & Bogue, 2009; Raelin et al., 2014; Rosenberg-Kima, Baylor, Plant, & Doerr, 2008); or, 4) a combination of the three—changes in self-efficacy after an intervention and a comparison between groups (see: Cordero, Porter, Israel, & Brown, 2010; Jones, Paretti, Hein, & Knott, 2010).

Two of the 28 studies utilize self-efficacy theory in conjunction with the expectancy value theoretical model. McCormick, Bielefeldt, Swan, and Paterson (2015) write that the expectancy value theoretical model posits, "that an individual's choice, persistence and performance can be explained by his or her beliefs about how well he/she will do on an activity, and the extent to which he/she values the activity (Eccles, 1983; Wigfield and Eccles, 1992; Wigfield and Eccles, 2000)" (pp. 138-139). More specifically, individuals approach tasks based on whether they think participation will lead to an outcome they value. Through this lens, McCormick et al. (2015) consider students' attitudes regarding sustainable engineering, where they correlate experiential learning endeavors to higher self-efficacy and sense of value in sustainable engineering. Similarly, Jones, Paretti, Hein, and Knott (2010) use both theories together to understand differences between male and female first-year engineering students.

Building on self-efficacy, Dugan, Fath, Howes, Lavelle, and Polanin (2013) consider leader efficacy of college women in STEM compared to non-STEM peers, where, "leader efficacy refers to personal beliefs in one's capacity to lead and is a critical predictor of the likelihood that an individual enacts leadership capacity (Hannah, Avolio, Luthans, & Harms, 2008; Komives & Dugan, 2010; Paglis, 2010)" (Dugan, Fath, Howes, Lavelle, & Polanin, 2013, p. 8). Similarly, Cech, Rubineau, Silbey, and Seron (2011) use professional role confidence, "[an] individual's confidence in their ability to fill the expected roles, competencies, and identity features of a successful member of their profession" (p. 642), to explain that women have less of this professional role confidence, and, as a result, depart undergraduate engineering at a greater rate than men.

Self-efficacy is a component of social cognitive theory, where in addition to self-efficacy, self-observation, self-evaluation, and self-reaction also influence motivation and goal attainment. Litzler, Samuelson, and Lorah (2014) use social cognitive theory to compare the STEM-confidence of different types of undergraduate engineering students. In the same theoretical family, in an analysis of the gender gap in undergraduate engineering majors over the last forty years, Sax et al. (2016) utilize social cognitive career theory's model of career-related choice behavior, which explains that "personal characteristics and backgrounds lead to learning experiences that influence one's perceived self-efficacy (the belief that one will be successful at a given task) and their expectations of career-related outcomes" (p. 576). In sum, self-efficacy theory, or a related theory, is used in 13—almost half of the 28—studies exploring the experiences of undergraduate women in engineering using theory at a level five. Further, one of these articles had a mixed methods design, while the rest utilized only quantitative methods. Due to the availability of established, valid self-efficacy survey instruments, self-efficacy theory is easily adapted to quantitative studies.

Leading to a sense of belonging. To consider the experiences of women in engineering and STEM overall, theories addressing leading to a sense of belonging, or a sense of fit, have also been used. In her quantitative study, Espinosa (2011) uses Weidman's (1989) theory of undergraduate socialization to evaluate the persistence of women of color in STEM and determine whether institutional type affected this persistence. Weidman's (1989) theory of undergraduate socialization explains that students are integrated into the university through relationships, and that these relationships (or lack thereof) with peers, faculty, and other campus groups affect their sense of belonging, which, in turn, affects persistence.

Another theoretical framework used to consider the sense of belonging of women in STEM, especially women of color, is Hurtado, Clayton-Pederson, Allen, and Milem's (1998) racial climate framework where, "historical legacy, structural diversity and psychological and behavioral dimensions of an institutional context shape how students experience the campus racial climate" (Rincón & George-Jackson, 2016, p. 742). Rincón and George-Jackson (2016) extend this framework to quantitatively consider the experiences of women in STEM majors especially as they relate to their departments and STEM intervention programs. In a mixed methods design, Kahveci, Southerland, and Gilmer (2008) consider the implications of one such STEM intervention program—a living learning program—through the theoretical lens of situated learning, where not just learning, but also participation in a community of practice is important for women (Lave & Wenger, 1991; Wenger, 1998). Historically women are marginalized from science, mathematics, and engineering communities of practice (Kahveci, Southerland, & Gilmer, 2008), which disadvantages them. One contributing factor to this marginalization is stereotype threat—another theoretical lens to consider the experiences of women in engineering, or the fear of confirming a group stereotype, which increases one's anxiety and negatively affects one's performance. For example, Serva, Baroudi, and Kydd's (2009) use stereotype threat in their quantitative study to understand differences between women and men in IT related majors.

To mitigate stereotypes, unfriendly climates and marginalization from STEM communities of practice, Creamer's (2012) theoretical approach in her mixed methods study, considering women's experiences in engineering, is the theory of critical mass. The theory of critical mass, "contends that there is a point at which the number of women in a particular environment brings about qualitative improvement in conditions and accelerates dynamics of change (Etzkowitz, Kemelgor, & Uzzi, 2000; Lagesen, 2007)" (p. 2). In this sense, Creamer (2012) seeks to prove that a sense of fit, where women see more women—more people that look like them in engineering—would mitigate chilly climates and stereotypes.

The importance of others is also relevant in Lin's (2000) network theory of social capital, where one's network impacts access to social capital, or resources and influence. Martin, Simmons, and Yu (2013) use social capital theory in their qualitative study to explore the experiences of Hispanic women engineering majors whose parents had limited post-secondary education, and thus had limited access to social capital, which affected their propensity to pursue or succeed in engineering. In contrast, Brawner, Camacho, Lord, Long, and Ohland (2012) use the social capital framework in their mixed methods study addressing why industrial engineering is appealing to women. The women in the study indicated that they were drawn to industrial engineering because they found it flexible, warm, collegial, and lucrative for future employment.

Identity. In the remaining relevant articles, the authors consider the role of identity in the experiences of women in engineering and STEM. Beddoes and Borrego (2011) conducted a meta literature review of engineering education scholarship to consider how feminist theory has been used and how it can be further advanced. Feminist theory has many different branches but overall intends to improve the conditions or women, recognizing their unique experiences and knowledge, especially in relation to men. Building upon this concept, Ro and Loya (2015) quantitatively utilize feminist intersectionality theory to ascertain whether negative experiences for women in engineering are worse for Black women than White women. Hanson (2013) uses the same theoretical approach to understand the experiences of Latinas. Intersectionality theories allow the authors to consider both gender and race identities and the intersection of the two in the experiences of their participants. Considering race apart from gender, in a qualitative study, Smith (2016) uses Boykin and Toms' (1985) triple quandary theory—identifying the interaction between mainstream experience, black cultural socialization, and minority socialization experience—to explore the experiences of African American females in STEM degrees at an HBCU.

Of the 28 relevant articles, two articles use theoretical lenses which focus on gender identity alone. Kim, Fann, and Misa-Escalante (2011) utilize Valian's (1999) theory in their mixed methods study, which explains that the imbalance of women and men in academia is attributed to gender schemas and accumulation of advantage. Gender schemas are invisible factors that favor males and can accumulate and ultimately lead to a decrease in women's confidence and outcome expectations. Kim et al. (2011) utilize this work to consider gender equity in Computer Science and Engineering (CSE) Research Experiences for Undergraduate (REU) internship programs. Alternatively, in a quantitative study, Cech (2015) considers gender as it relates to professional identity. To Cech (2015) engineering professional identities may conflict with women's self-conceptions, which make them less drawn to or successful in the field of engineering.

Lastly, regarding identity, Carlone and Johnson's (2007) science identity is also used by Espinosa (2011) to consider the experiences of women, especially women of color in STEM. Science identity relates to one's competence, performance, and recognition in science and the interaction of these components with one's other identities.

In summary, over the last decade, the peer reviewed articles focused on undergraduate women in engineering in the United States consistently use theory—meaning they used theory at a level five (Bradbury-Jones et al., 2014)—only 44% of the time. Articles were disqualified from this review because they were outside of the time frame, did not focus on undergraduate women in STEM or engineering in the United States, or they insufficiently applied theory per Bradbury-Jones et al.'s (2014) typology. Of the articles that did meet the parameters for this review, self-efficacy theory, or theories related to self-efficacy were used the most. Additional theoretical lenses were categorized as leading to a sense of belonging and identity. If these studies had been designed without a theoretical framework, would their results differ? Or, if disqualified studies had used theory sufficiently throughout their research design (at a level 5), how would this review have changed? The next section of this paper approaches these questions.

Part 2: Does theory matter? A two-part narrative study

In this section, two parts of a qualitative study—one part designed around a theory and one part not—are compared to demonstrate if engineering undergraduate women's narratives, or the subsequent interpretation of those narratives differ when theory is central to the research design. In this two-part qualitative study, the purpose of the first part was to better understand the experiences of undergraduate women graduating with degrees in engineering from a Southern, top-tier research, Predominately White Institution (PWI), while the purpose of the second part was to explore whether Jaeger et. al.'s (2017) Life Experiences and Role Negotiations (LEARN) Model could be used to understand the learning and career-seeking experiences and trajectories of undergraduate women graduating with degrees in engineering from the same institution.

When the storied experiences of individuals are important, like those of women in engineering, narrative research is the most appropriate qualitative research design. Narrative research explores life experiences (Clandinin, 2014; Creswell, 2013), especially as they relate to the construction of one's career identity (LaPointe, 2010). A narrative approach empowers participants to define their own salient themes or what themes are most important to them (Elliott, 2012). Most importantly, narrative research, "[honors] lived experience as a source of important knowledge and understanding" (Clandinin, 2014, p. 17). In this way, narrative research is used in this two-part study to acknowledge the importance of the participants' stories in understanding the true experience of women in engineering.

Participants and Site Selection.

For this two-part narrative study, purposeful sampling (Merriam & Tisdell, 2015) was used to recruit eleven participants. Participants self-identified as a woman, were enrolled full-time in an engineering degree program for at least three consecutive years but planned to graduate during the current academic year, and had at least a 2.0 GPA. These women all attended a predominantly White, land grant, tier-one research institution in the South. Land grant institutions support a wide range of agriculture, science, and engineering programs per their missions (Marcus & Geiger, 2015). The participation solicitation was conducted via an email identifying eligibility and incentive information (a ten-dollar Starbucks gift card). The women were 21-24 years of age earning degrees in aerospace, biomedical, chemical, industrial, nuclear, and mechanical engineering or computer science. Per a demographic survey (Appendix A), eight of the participants identified as White, one of the participants identified as African American, one identified as two or more races, and one identified as "a type of brown not captured by the U.S. census."

Data Collection and Data Analysis.

To generate data, the women in this study participated in two one-on-one hour-long interviews (one for each part of the study)—the most appropriate way to get full, rich data quickly (Forsey, 2012)—in a university library study room. Protocols for both interviews are included in the appendix. To make the interviews distinct, at the beginning of the second interview, participants were asked to treat the second interview as though the first interview had not happened. They were invited to repeat stories if they felt they best addressed the question asked of them, and they were asked to refrain from referencing the previous interview. The interviews were audio-recorded and transcribed, and then underwent narrative analysis. Narrative analysis "uses stories people tell, analyzing them in various ways, to understand the meaning of the experiences as revealed in the story" (Merriam & Tisdell, 2015, p. 24).

The first part of this study, the one without theory, is centered on the first interview which focused on the participants' own interpretations of their experiences in engineering. To help the participants think about their experiences, the researcher suggested the women reflect on and be prepared to answer the following questions: "In twenty years, imagine you are featured in a magazine about successful women. What would your article say? What are your history and your future especially in regards to engineering?" The advantage to this open-ended approach was that it allowed the participant to generate her own meaning from her experiences. The resultant data underwent eclectic coding, which included a combination of first cycle coding methods (Saldaña, 2012), such as: process coding that used gerunds to signal action in data (Charmaz, 2002), in vivo coding which used participants' own words, narrative coding that applied literary elements to tell stories (Saldaña, 2012), and values coding where codes reflected, "values, attitudes, and beliefs, representing his or her perspectives or worldview" (Saldaña, 2012, p. 110). Next, the materials were reviewed a second time using second cycle coding, which included axial coding methods to remove redundant and less important codes, and a third time using pattern coding methods to look for salient themes (Saldaña, 2012). Later, study participants also completed a Qualtrics survey to indicate their agreement with the study's main themes. Again, theory was not used in the research design of this part of the study.

In contrast, the second interview was framed by Jaeger, Hudson, Pasque, Ampaw's (2017) LEARN Model, where participants were asked to reflect on their pasts, presents, and futures respectively. When interview participants are asked to reflect on specific time periods and situations, narrative interviews work best (Hollway & Jefferson, 2000). Again, the participants were asked to treat the second interview as though the first one had not occurred to prevent the participants from withholding information that might be relevant to these questions. The materials from the second interviews were coded to elements of the LEARN Model. Detailed memoing and multiple rounds of coding ensured consistency.

Finally, for the purposes of this paper, the codes from the first and second interviews, were compared using a form of constant comparative analysis. The constant comparative analysis (CCA) method originates from Glaser and Strauss' (1967) grounded theory methodology; however, "[i]t must be clear that constant comparison, the data analysis method, does not in and of itself constitute a grounded theory design" (O'Connor, Netting, & Thomas, 2008, p. 41). What it does ensure is that "all data are systematically compared to all other data in the data set" (O'Connor et al., 2008, p. 41). Through this systematic comparison, classic grounded theory highlights three types of comparisons where incidents are data points (Fram, 2013): incident to incident; concepts emerging from further incidents in new data; and concept to concept (Glaser & Strauss, 1967).

After coding is complete, in their published works, very few researchers detail their steps for CCA. In contrast, Boeije (2002) proposes a purposeful approach to CCA, she includes five levels of comparison: 1) comparison within a single interview; 2) comparison between interviews within the same group; 3) comparison of interviews from different groups; 4) comparison in pairs at the level of the couple; and 5) comparing couples (p. 395). Unlike Boeije, this study did not include interviews with different groups of participants, such as those participants that decided to depart from the engineering field. For the purposes of this inquiry—to determine if the use of theory made a difference in the narratives of the female undergraduate engineering participants—the codes of the first interview (no theory in the research design) and second interview (designed using the LEARN model) are compared.

Comparison

While the codes from both studies are compared, themes group codes to summarize the data. From the storied experiences of the women in the first interview (no theory), four major themes emerged: sexism, self-doubt and feeling like an imposter, enacting a growth mindset, and using engineering to do good. The second interview yielded themes that represented elements of the LEARN model, which was central to the research design (addressing if the LEARN model could be used to understand the experiences of undergraduate women in engineering). The second interview themes included: continuous personal determinants, the environment, past determinants, learning, present determinants, decisions, and future career outcomes. Comparing the codes that made up these themes from both interview one and two introduced some new, overall themes to categorize the storied experiences of these undergraduate women in engineering: I don’t like this and I don’t belong, I don’t know if I deserve to be here, taking a positive strategic perspective, increasing women’s representation, and engineering a better future. While the women told different stories at each interview these new, overall themes transcended both interviews. The mapping for these new themes and relevant codes is detailed in Table 3.1.

Table 3.1.

New themes and mapped codes from interviews one and two

New Theme	Interview One Codes (No Theory)	Interview Two Codes (LEARN Model)
I don't like this and I don't belong	• Implicit Bias • Explicit Bias • I really don't want to do engineering anymore	• Instrumental Learning Experiences (-) • Marginalization
I don't know if I deserve to be here	• Imposter syndrome • Self-efficacy	• Self-concept • Self-efficacy and self-assessments
Taking a positive strategic perspective	• Growth mindset	• Agency
Increasing women's representation	• Recruiting more women	• Identity (Sociocultural)
Engineering a better future	• Meaningful Coursework and Careers	• Instrumental Learning Experiences (+) • Role Expectations • Goal Representations

I don't like this and I don't belong. In the first interview participants spoke about implicit and explicit bias, which created feelings of discomfort and ultimately made them question whether they belonged. All the women told stories demonstrating implicit bias, for example, Susan in mechanical engineering explained that she felt like she might not belong because she did not have experience with power tools:

> We were divided into groups of five and I'm the only girl and its just kind of [nerve wracking]. Now we're in the machine shop actually building, so it's definitely a change of dynamic from sitting in class with all the guys versus hearing them do their

> shop talk or whatever. It can be kind of intimidating because all of the TAs are guys, also, and when you ask for help using a machine, I feel like it's like they're judging me because I don't know how to use it. I feel like guys are brought up using power tools and stuff and I've never used anything like that, so I'm trying to make sure I don't cut my arm off or anything and they're just giving me a hard time… We have to check out certain tools from this closet and there's supposed to be someone sitting in the closet at all times, but in one particular case, I was with this other guy in my group. We went over to the closet and no one was there, so we went over to the table where all of the TAs were sitting and I was just like, "Can someone- I need to check out a grinder. Can someone help me," and they all just stared at [my partner].

The TAs did not help Susan when she asked but instead looked to the male student that she was with in exasperation. If this experience had been shared in the second interview, it would have been coded as a negative instrumental learning experience, or past determinant. Instrumental learning experiences lead women to develop an affinity or aversion to STEM (Jaeger et al., 2017). Additionally, in the second interview, it could have been coded to marginalization, as Susan's lack of sense of belonging is evidence of her feeling marginalized from her environment. Nevertheless, even though implicit or explicit bias could easily have been coded to fit the LEARN model, similar codes did not emerge from the women's second interview narratives. These are difficult topics so it may be that the participants did not want to talk about them again, or it could be that the LEARN model does not extend to illustrate implicit or explicit bias.

Instead of implicit or explicit bias, the negative instrumental learning experiences detailed in the second interview more so pertained to challenging or boring coursework. Phoebe, a chemical engineering student had an aversion to her major because of the heavy workload:

> I had long nights and everything, and it kinda makes you like, "Is this really worth it? Do I really want to struggle?" When you have five classes and none of them are easier than the other, it kinda makes you say, "Okay, maybe I can do something else that's a lot easier. I won't stay up all night." I think once I got into my actual major classes, it makes you doubt it. I think it continues all the way to the end. Still now, I'm like "Why did I pick this to major in?" But then it's kinda like "Well, I've made it this far, so I might as well finish." I think once you get into your courses you really start to doubt yourself because you see how much the workload is.

Even though she persisted in Chemical Engineering, Phoebe indicated that she had to make the decision to stay. If this had been shared in the first interview, a code used for the first interviews' early data analysis, "I really don't want to do engineering anymore," could have been used. However, this code was found to be less representative of all the participants' narratives, and after axial coding, was not included in the first interview's final codebook (Saldaña, 2012). This means that while it was not a major code in the first interview, this concept—of not wanting to continue with engineering because it is so hard—resonated for some participants in both interviews.

The environment, another LEARN model theme in the second interview, is also evident in Phoebe's story. Both Susan and Phoebe felt marginalized by their environment because of their experiences. Marginalization is a code of the environment theme in the second interview's data analysis. Like Phoebe, Monica, a chemical engineering student, described in her second interview how the engineering campus makes her feel:

> I don't hang out a lot in engineering campus, I think it's a little bit grim there, so I like to hang out around here on main campus because people smile and they talk a lot more. I notice, and I try not to do this, I might be guilty though. People will say things that implicitly show that because they're an engineer they are better than some other student. I notice that as one big identifier of engineers, is this sort of business like tone that they have in class. It may not be how they actually are as a person, but they pretend to, they wear this hat of like the business, working efficiently, that type of student. Then they rag on other majors. They rag on, in particular humanities majors. Although I mean it extends to whomever they think is not working as hard as they are.

Monica thinks engineers act superior and she does not like their unfriendliness. Monica felt marginalized from the engineering campus and her fellow students, which could have led her to leave engineering. Whether it was a negative instrumental learning experience—sexist or not, or an example of feeling marginalized by the environment, these women questioned staying in their engineering majors. The culmination of codes in these areas suggest that, at times, the participants felt "I don't like this and I don't belong".

I don't know if I deserve to be here. Feelings of self-doubt were also evident in the women's stories in both interviews, which leads to the next, new theme of "I don't know if I deserve to be here". Feeling like an imposter is akin to low levels of self-concept, which is one's perception about her performance relative to her peers' performances. In the LEARN model, self-concept is a continuous personal determinant, meaning that women must negotiate their self-concept throughout their trajectories just like they had to in the past (Jaeger et al., 2017).

In the first interview, Janis, a chemical engineering student, provided this example of low levels of self-concept when she questioned whether she should be in the major:

> Sometimes I wonder if I only got into the chemical engineering program because I'm a woman and they wanted to fill those minority spaces, just because I was the valedictorian that might have gotten me in, but my salutatorian was a male and he didn't even get into the engineering program. It's like we were so close in GPA and in extra-curriculars but I got in and he didn't even get into the engineering college. Was it because I was a woman or was it because I had a better GPA and maybe I did a couple extra activities, so sometimes I think about that.

Janis questioned if she only got accepted into the chemical engineering major because she is a woman. In the first interview, where this story was told, this narrative was coded to imposter syndrome. In the second interview, Rachel, an aerospace engineering student, also indicates she has doubted in her abilities compared to her peers:

> The technical stuff, I feel super confident in the math portion and my grades would suggest that I'm confident and capable in the academic portion of it, but there's definitely a lot of doubt when it comes to sitting down and doing an assignment. I'll do it and I'll follow my notes and I'll feel really confident and I'll do it again, just to really ingrain that in myself. Then I'll turn it in and I'll just be sort of on edge, like I did the best I could, but I'm not sure if I'm going to get a zero or 100 or somewhere in between until I actually get my papers back. I think what I expect is that the insurance comes from just getting my work back and seeing that it's an A or a B or a C or a D or an F, but even with that, I worry that I'm the only person that feels that way and I think it's because of the way that other students carry themselves. They've got a lot of swagger that they bring to it where it's like, "Oh, I did this assignment. I know how this assignment goes. I know what I'm doing."

As part of the second interview, this was coded to self-concept. Rachel is less confident about her assignments than her peers, so that makes her doubt her own work. Other women, in both interviews, more directly labeled themselves imposters—remember, this was a code from the first interview.

Self-efficacy also feeds into this concept of belonging and whether you are good enough. Self-efficacy is the belief in one's own abilities (Lent, Brown, & Hackett, 1994), and it is a present determinant in Jaeger et al.'s (2017) LEARN Model. Many of the participants in their second interviews told stories about feeling confident in their academic abilities but not necessarily their professional capabilities. For example, Ursula explained:

> When I think about my engineering ability I think about it in the real world, like out in the job. And so far my internships, I feel like I haven't done ... They're pretty challenging because I didn't know what I was doing. So, I feel like I have kind of bad engineering ability, because I'm good at doing the tests and getting good grades. But when it comes time to face a real world complex problem it's kind of hard for me to like ... I don't know, I feel like I'm not good at that.

Per the LEARN model (Jaeger, Hudson, Pasque, & Ampaw, 2017), Ursula's self-efficacy and self-assessment at her present stage influence her future and if she can persist into an engineering career. Self-efficacy was also a code used in the first interview, like Ursula, Emily, a biomedical engineering student, thought she had academic skills but not "real world" skills:

> I definitely think I'll be prepared for grad school just with the research experiences I have had. I've made it my effort to get the skills that I need, that I don't feel that my program has provided me and specially the bio-materials students they don't have the same lab classes that the other concentrations do so bio-mechanics and bio-instrumentation students they get additional lecture in laboratory courses, where ours are solely lecture, so I feel that we are missing some of the more hands on skills that we could've earned.

While some of the participants may not feel confident in their performances when compared to their peers, many do feel confident in their academic abilities and preparedness for further education. Unfortunately, as the women are all about to enter the workforce, they feel less prepared for their next professional steps. Feelings of self-doubt, feeling like an imposter, low levels of self-concept, and low levels of self-efficacy were present in the participants' stories in both interviews one and two, which demonstrated the ways the women questioned whether they deserved to be there, "there" taking different meanings throughout their engineering trajectories.

Taking a positive strategic perspective. One way to combat feeling like an imposter is to take a strategic perspective, such as, a growth mindset to care about learning, and employ more positive strategies to accomplish goals, like an increase in effort (Blackwell, Trzesniewski, & Dweck, 2007). After comparing the codes from interview one and interview two, taking a positive strategic perspective emerged as the next theme for this paper. The process of enacting a growth mindset is one of the codes and ultimate themes that emerged from the first interview. This first interview code is related to the second interview code of agency, or the strategic perspectives and/or actions one takes to achieve one's goals (O'Meara, Campbell & Terosky, 2011). Agency is a component of Jaeger et al.'s (2017) continuous personal determinants.

In the first interview, Mindy, a nuclear engineering major, told this story about enacting a growth mindset:

> I don't tell a lot of people but I actually failed Physics 1 when I first got here. That was one of my worst moments in engineering, as well as one of my best, because had it not shown me how I need to go about my next three years, I would have not flunked there, but somewhere where it was a bit more important. So, for nuke we're

cyclical, if you fail a class, you have to wait a whole year to take it again… I would say just doubting yourself, because the doubt is always there. You know, I just didn't know how to study for it, and I think off the bat I was dejected to study for it because I didn't get one or two of the first topics, so okay I was kind of studying. And then when you go to the professors, sometimes... the professors are usually great when you go help, but I think I was just so not getting it, that from there it just made me less and less want to... which I think you hear a lot, kids even younger ages they get dejected or they get told they're wrong, or they don't know and then… It spirals. That's what happened, it spiraled from there because I was so... I tried really hard. But when I took it again and I got the first... man much better. Because I took it in high school, but the high school I went to was kind of "lets graduate and not get you pregnant". And I hate to put it that way, but that's the reality of what it was. It's a good day when people are going to community college there. I don't think they were exactly... not keen, but I wasn't a priority to make sure I was ready for an institution like this. I got with a friend that I knew was very good at this stuff, so I would sit down and work through the problems and immediately when I didn't understand something, I worked it out now I'm taking it to the professor. I wasn't going to wait and try again, there was an immediate turn... every time there was a new topic, go practice it, do the homework, and then immediately bring it to him. And then when it's time to study for an exam, you go through every single topic and you go through it with that friend, and you make sure you can answer the questions that you haven't... you know how

> you might have already memorized the homework answer, so you're like "oh I know how to do this", but I show you the same problem but completely different numbers and you're like "I don't know how to do this". So, I made sure I knew how to do that… Nuke I think is more a gut-check more than anything. It was just a lot of gut-checks and I think getting through that... Support of your friends is good, but you have to believe in yourself. Because I just had to buckle down and say "okay, you have to do this and if you get a zero on it, that's fine, but you at least need to turn in something". I ended up getting a 98, so yeah.

Mindy failed Physics, but instead of deciding to give up, she changed the way she thought about this negative experience which allowed her to shift her behavior—failing Physics taught her how to better approach her other classes. This increase in effort is evidence of a growth mindset (Blackwell, Trzesniewski, & Dweck, 2007). Continuing with her positive mindset, Mindy also said in her second interview, "you'd be surprised what you can do if you give yourself the motivation and the open mindedness and creativity. Even with other people, you'd be really surprised what you can do if you just let go of that and just do it. Sometimes you don't know where to start." Mindy was very positive about her overall experience in engineering and overcoming the associated challenges.

Like Mindy's efforts to work harder that she described in her first interview, other women in their second interviews spoke about their strategic actions to reach their goals. In one example Julie explained,

> I received an email this morning about how to handle a case study interview, which is frequently what any tough consulting basically consists of, right? So, I signed up for this event that's going to help me basically ace an interview that might be coming up in the future. I think exposing myself a little more, learning about what the job consists of so when I interview with a particular employer, I always google the questions that they might be asking, so I'm just preparing myself.

Julie, like all the women, were seeking jobs for after graduation. This example shows the steps that she was taking to reach her goal of finding a consulting employment position. While growth mindset, the first interview code, is attributed to learning in math and science, and one believing that she can learn, it is still a positive behavior to reach one's goals. The second interview code, agency, in contrast, is not isolated to learning and can extend to any number of actions a person takes to reach her goals. Nevertheless, these codes from both interviews relate to one another in the way that the stories from both interviews demonstrate the ways in which the participants take positive perspectives to reach their goals.

Increasing women's representation. Another theme that emerged from the first interview was "engineering to do good." One subtheme of "engineering to do good" was wanting to recruit more women to the field of engineering.

Janis, a chemical engineering student, eloquently spoke about recruiting more women to engineering in both her interviews. In the first, she said this about a potential magazine article about herself, "I'd really love it to say that I was a person who really tried to encourage more in younger women to get into STEM fields and really just saying that you can really have it all. You don't have to give up your personal life over your engineering career. You can find ways to make both of those happen." Then, in her second interview she said,

> Just knowing that there aren't a lot of women in engineering, I think that just kind of helped me. It made me more determined to be an engineer, knowing that there weren't a lot and I wanted to be one of the few that are. Then hopefully when I get into a position where I have more influence, I can bring other women into the engineering programs or get them excited about STEM. I know, I'm already starting on my niece, just giving her little science-y little things to work on.

Like many of the other women in the study, increasing women's representation in engineering is important to Janis. The first quote is associated to the first interview's theme of "engineering to do good," but the second quote is attached to the identity code from the second interview. Identity is a continuous personal determinant of Jaeger et al.'s (2017) LEARN model, and it was very much present in all of the women's storied experiences. This means that the negotiation of one's identity continuously played a role in the decision to stay or leave engineering.

Engineering a better future. The second subtheme of "engineering to do good" in the first interview pertained to the women wanting to use engineering to better society. For example, Judy wanted to use her degree in computer science to protect the United States from cyber terrorism. She realized this after an industry-based work experience, explaining that:

> I've always wanted to help people. One of the companies I worked for was a company that sort of catered to non-profits. They made software to help them fundraise. I was super stoked about that. I was doing that, it was great. Then, I learned, kind of somewhere down the line that our software had a multi-million-dollar price tag. These fundraiser that were raising two extra million dollars for their thing, it was just going right back to their company to keep the subscription. It was discouraging. I decided, industry might not be for me. I want what I do to actually make a difference, I want to actually help people, I want to actually protect people. I can do that in the US. I can do that in Kenya or Nairobi or anywhere. I really ... with the way things are going right now, it just seems like a better plan to protect my home.

Judy wants her engineering work to make a difference in the lives of others. If the full narrative around this storied experience had been mentioned in the second interview, it would have been coded three ways: goal expectations, role expectations, and instrumental learning experiences.

Goal representations is a present determinant in the LEARN model (Jaeger et al., 2017). Through goal representations, the women set goals to guide their behaviors (Lent, Brown, & Hackett, 1994). For example, in her second interview, Phoebe, a chemical engineering student, reflected on her goals:

> I want to go back to school and get a nursing degree. I want to invest in businesses. I want a family. I just think there's a lot of other things I want to do outside of engineering, but engineering is a good lead into other things that I want to do. I think

> coming into it, I was kind of blinded and maybe ignored other things I wanted to do in life, but then as I got further down the line, I'm like "There's other things that I'm actually interested in than engineering. I enjoy engineering, but maybe down the line I can do something else." I think realizing that it's actually possible for me to do something else was the biggest thing. I think I kind of at one point thought "Okay, I'm an engineer major. This is what I have to do for the rest of my life." I think that would be the biggest thing. I think just wanting to be involved in the medical field. I can as an engineer, but being more hands on with people.

Phoebe's coursework will help her meet the goal of earning a degree in chemical engineering. As Phoebe rationalized, her degree in chemical engineering will help her achieve her goal to become a nurse.

Role expectations pertain to future career outcomes and what types of roles the women envision for themselves (Jaeger et al., 2017). These roles are connected to the women's goals and all the work the women are doing in the present. For example, Judy is applying to graduate school to get cybersecurity experience so she can have the job she wants in the future, and Phoebe is going to apply to nursing school. In the second interview, some of the women had role expectations that also demonstrated a propensity to improve society, like Judy and Phoebe, but others did not. Rachel, an aerospace engineering major, had quite a few roles that she considered:

> There's definitely the business Rachel wearing nice, not pantsuits but the equivalent of pantsuits and stomping down New York City to my engineering firm with latte in

hand and reinventing the airplane, something like that. That's always the picture that's in everyone's mind, but there's also the part of me that wants to be in an aircraft hangar working with my hands and putting together an actual airplane. Then there's the part of me that wants to teach because if I could have such a positive experience with certain educators in my life, I want to be able to give that experience back. Then there's the me that wants to go down to countries that are super dependent on foreign oil and say "Hey, it doesn't have to be this way. Let's overthrow the man. Let me give you wind energy." Stuff like that. All of those sorts of things sort of seems just like dangling like ornaments in my future five to ten years from now. There's, if I go the super cool, snazzy adult Rachel who pounds the pavement of New York, I'll make bank, hopefully, and that would be awesome. If I choose to go hands on and lock myself in an aircraft hangar and just build airplanes, that'd be cool. I'd probably be able to pay my bills, but I'd probably be pretty bored since I wouldn't be using the really rigorous mathematical stuff and the physics that I've learned. Then, it just, the ornament in front of me about going to a foreign country that's dependent on foreign oil and being like, "Hey, this doesn't have to be how it is." Feels very like freedom fighter and it feels more like me, but that doesn't take away from how much I want to live in an aircraft hangar and how much I want to pound the pavement, so, I think I just have to be true to myself and that one's going to feel the best.

Rachel envisions a corporate future, a hands-on, mechanical future, a future as an educator, and a future as a “freedom fighter.” To Rachel, her engineering degree afforded her an opportunity to consider different future roles.

Judy’s narrative to use “engineering to do good” from the first interview could also be attributed to an instrumental learning experience code from the second interview, or a past determinant. Specifically, Judy made the decision to pursue a government career after learning that she did not like working in industry. In the second interview, many of the positive instrumental learning experiences pertained to childhood events where the women realized that they wanted to be engineers. For example, Carol, an industrial engineering major, shared a photo of a trip with her dad and described spending time with him:

> I have this picture. That's my dad and I when I was probably five, six. I don't know how old I was but this is the first time I really remember being so excited to see to understand how big of a project engineers can work on. This one is I'm pretty sure the one in Huntsville, Alabama, to the space center there. We were walking through this building and they have the whole Saturn-5 on its side and that building is huge. It was absolutely insane. My dad was talking about all the different kinds of people that would work on it and hundreds and hundreds. They had this wall of all of the major scientists and the major engineers and the different astronauts. I can remember being so blown away because I was like this big compared to this giant rocket. I think a part of it too is that my dad and I always, he's definitely a workaholic so when he would take time to play with me or show me something, it was usually space themed. We

> would have daddy-daughter dates to the planetarium and we would build our own model rockets and go out on the weekends and launch them. We always had this connection [because, I realized] when I get attention, it's when I like space.

Even though Carol might have partially participated in these events to get her dad's attention. She also genuinely was interested in space exploration. She later told this story, "On Thursday, we had an astronaut come into our class and talk to us and I just got lost there like this is the coolest thing. She was saying, 'Yeah, I've been on the shuttle three times.'; I'm like, 'I can't believe you've been to space and you're here talking to us.'" These positive instrument learning experiences, like Carol's, led the women to decide to pursue engineering, which, ultimately, points to a future role in engineering. In sum, narratives coded to meaningful coursework and careers in the first interview, and from the second interview similar narratives coded to goal representations, role expectations, and positive learning experiences demonstrate a larger propensity of some of the women to want to use engineering for a better future.

Overall, while interview one did not incorporate theory into its research design, the emergent codes were relatable to the codes of interview two, which was designed around Jaeger et al.'s (2017) LEARN Model. In this way, for the most part, the participants shared different storied experiences in each interview, but the meaning behind those different storied experiences is the same—with one exception. In the first interview, participants told stories of implicit and explicit bias which were not repeated in any form during interview two.

Potential reasons for this difference, and what the results of this comparison mean are detailed in the third and final part of this paper.

Part 3: Discussion, Implications and Conclusions

The design of the study detailed in part two of this paper is not without challenges. For many of the participants, the first interview provided an opportunity to reflect on their experiences, which, in turn, may have influenced their narratives in their second interviews. Conversely, at the beginning of their second interviews, participants were advised to treat the second interviews as though the first ones had not happened, meaning they should feel comfortable to repeat themselves if they thought it was appropriate. Nevertheless, could the absence of a topic, especially one that made the participants uncomfortable—like implicit and explicit bias, which are especially hard to discuss—be since they thought they had already shared the experience and did not want to talk about it again? If this research design is to be replicated, participants should participate in some type of reflection exercise prior to the first interview to try and mitigate these challenges. This reflection would serve as a third data point and allow the participants to organize their thoughts and be better prepared for the interviews. Additionally, more time between interviews could help prevent participants from withholding information that they think they have already shared. For the purposes of the two-part study identified in part two of this paper, interviews were conducted within a few weeks of one another to keep participants engaged.

The current literature

Further research opportunities also avail themselves through the comparison of part one—the meta literature review of studies on undergraduate women in engineering over the last ten years which used theory consistently per Bradbury-Jones et al.'s (2014) "levels of theoretical visibility typology" (p. 137)—and part two (the two-interview study) of this paper. Where does the study from part two of this paper fit into the findings of part one of the paper? Table 3.2 highlights this mapping discussed here.

Table 3.2

Situating the themes from part two into the literature found through part one

Theme from two-part study	Theme from review of literature	Theories in literature (Level 5)
I don’t like this and I don’t belong	Leading to a sense of belonging	• Theory of undergraduate socialization • Racial climate framework • Situated learning and communities of practice • Stereotype threat • Theory of Critical Mass • Network Theory of Social Capital
I don’t know if I deserve to be here	Confidence in ability	• Self-efficacy Theory • Professional Role Confidence
Taking a positive strategic perspective	N/A	N/A
Increasing women’s representation	Leading to a sense of belonging	• Theory of Critical Mass
Engineering a better future	N/A	N/A
All	Identity	• Feminist Theory • Feminist Intersectionality Theory • Triple Quandary Theory • Professional Identity • Science Identity

First, the narratives from part two associated with “I don’t like this and I don’t belong” align with the leading to sense of belonging literature detailed in part one. This literature utilized Weidman’s (1989) theory of undergraduate socialization, Hurtado et al.’s (1998) racial climate framework, Lave and Wenger, (1991) and Wenger’s (1998) situated learning and communities of practice, stereotype threat (see: Alpay et al, 2010; Beasley & Fischer, 2012; Steele & Aronson, 1995; Steele, James & Barnett, 2002; Van Loo & Rydell, 2014), the theory of critical mass (Etzkowitz et al., 2000; Lagesen, 2007), and Lin's (2000) network theory of social capital. Another theme from part two, "increasing women's representation" also aligns with this work, especially the theory of critical mass (Etzkowitz et al., 2000; Lagesen, 2007). This finding of the two-part study—that women struggle to feel like they belong in engineering—is situated in current literature exploring the same phenomena, where a wide range of theories are in use. This suggests that research has been robust in using theory to consider this phenomena that still needs attention as evidenced from part-two (the two-part narrative study) of this three-part paper. Perhaps future research efforts should address the suggested implications for practice that emerged from these studies. If research is appropriate to help understand women's sense of belonging in engineering, do theoretical implications for practice translate to improving women's sense of belonging in engineering? Further, are these implications for practice being implemented to improve the conditions of women in engineering?

Prevalent in the literature identified in part one of this paper, the literature found to consistently use theory to consider the experiences of undergraduate women in engineering over the last ten years, self-efficacy (see: Lent & Hackett, 1994) was a component of the "I don't know if I deserve to be here" theme, in addition to self-concept (see: Espinosa, 2008; Sax, 1994a; Sax, 1994b; Sax et al., 2015) and the imposter syndrome (see: Dahlvig, 2013; Parkman, 2016; Simmons, 2016). The study participants in part two of this paper, the two-interview study, did not feel prepared for their professional lives, which aligned with Cech et al.'s (2011) use of professional role confidence, in part one, the meta-literature review, to consider why undergraduate women depart engineering. This suggests that feelings of self-doubt, low levels of self-concept, low levels of self-efficacy, the imposter syndrome, and preparedness for future careers are explored with theory in the literature and continue to remain problematic for the engineering undergraduate women in this study. While further attention to implications for practice may also be valuable in addressing this phenomenon, current literature relies on the same theories, which suggested that new theoretical lenses might also be valuable in this arena.

The aforementioned new, overall themes to categorize the storied experiences of these undergraduate women in engineering (I don't like this and I don't belong, I don't know if I deserve to be here, taking a positive strategic perspective, and increasing women's representation) mostly align with recent theoretically driven research on undergraduate women in engineering. However, two of the themes do not fit this existing body of work and may suggest avenues for further inquiry: "taking a positive strategic perspective" and "engineering a better future." Interestingly, in contrast to the other theories, these unused themes take a positive approach to consider the experiences of women. Future research to explore this further might consider the positive psychology work of Barbara Frederickson or Martin Seligman and Mihaly Csikszentmihaly. Instead of focusing on women's deficiencies, these themes from this paper suggest behaviors of women who persist in engineering. The former, "taking a positive strategic perspective," pertains to the women's agency, or her strategic perspectives and actions to achieve her goals (O'Meara, Campbell, & Terosky, 2011), and enacting a growth mindset (see: Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 1999; Dweck, 2010; Grant & Dweck, 2003). The later, "engineering a better future", addresses the participants desire to use engineering to improve society. Potential theories to consider this phenomenon include those associated with community engagement, such as, Kolb's (1984) experiential learning theory or Mezirow's (1991, 2000) transformational learning process model. Future studies that wish to integrate theory throughout their design may incorporate these theoretical frameworks.

Lastly, identity was another emergent theme of the meta-literature review conducted in part-one of this paper. Like the leading to a sense of belonging literature theme, scholars utilize a variety of theories to consider this phenomenon—feminist theory, feminist intersectionality theory, triple quandary theory (Boykin & Toms, 2985), professional identity theory, and science identity theory (Carlone & Johnson, 2007). Identity did not emerge as an overall theme of the two-part study but it was still very much relevant to it. Jaeger et al. (2017) utilize identity as a continuous personal determinant, meaning that per their model, women continuously negotiate their identity (in their past, present, and future) as they make decisions about staying or leaving STEM. As a result, identity—both sociocultural and science identity—appeared frequently in the women's narratives suggesting that it intersects continuously with the women's storied experiences. This suggest that current literature recognizes the importance of identity in exploring the experiences of undergraduate women in engineering and STEM, however, the findings from part two of this paper suggest that identity theories should be layered on top of or integrated into other theories and not used in isolation.

Did the use of theory matter?

To the larger purpose of this paper, does using a theory to guide the design of a study affect the shared narratives of these women? In this case, it would suggest not. The storied experiences of the women yielded relatively the same themes whether theory was included or not. This suggests three possibilities. One, Jaeger et al.'s (2017) LEARN Model is a comprehensive theoretical framework to consider the experiences of undergraduate women in engineering. The LEARN model is flexible and inclusive enough to map to the nuanced experiences of the undergraduate engineering women who participated in this study. Or, two, that consistently using theory throughout a study is not as important as some scholars may imply. To truly ascertain if one or two are the case, the LEARN Model needs to be utilized in additional studies to more fully appreciate its fit. Or, finally, three, the research design of this study is faulty—that having the same participants participate in two interviews (one guided by theory and one not) is not an appropriate means to determine if theory affects their narratives. A different approach to pursue this line of inquiry would be to expand the parameters of the meta-literature review conducted in part-one of this paper to include studies that used theory insufficiently (levels 1-4) and review the difference of their findings compared to studies that did use theory at a level 5 (Bradbury-Jones et al., 2014). This literature comparison could identify gaps and overlaps where theory is used and when it is not.

Nevertheless, to the scholars who believe using theory throughout qualitative research leaves a better foundation for future researchers to continue the same line of inquiry (Beddoes & Borrego, 2011; Orton, 1997; Suddaby, 2006), yes, this demonstration of the relevance of the LEARN Model is a good justification for its use in future research, and scholars can follow similar methods to test it in their own ways especially in efforts to determine whether the LEARN model is a good fit for the experiences of women in STEM. Further, to the scholars who indicate that the use of theory may hinder academic discovery, or advancement in the field, in this study, that was not the case. Two themes—engineering a better future and taking a positive strategic perspective—appear to be unique contributions to the study of undergraduate women in engineering, at least in studies that utilize theory. If these themes are apparent in studies that do not sufficiently use theory, then we return to the central tenet of this paper: is theory needed and to what extent is it needed (at a level 5)? While this paper did not fully answer this question, it did introduce some doubt. Doubt on the part of researchers who over-rely on the same theories—like self-efficacy theory—which might stifle advancements in the field, and doubt on the part of consumers of higher education research which demand that theory be used in qualitative studies of higher education research. At the very least, when theory is demanded in academic research, this demand should be accompanied with empirical evidence that demonstrates what is missing when theory is not used.

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APPENDICES

Appendix A

Demographic Questionnaire

1. Please check the race/ethnicities that best describes you (check all that apply):

   ☐ Hispanic or Latino, of any race
   ☐ American Indian or Alaska Native, not Hispanic or Latino
   ☐ Asian, not Hispanic or Latino
   ☐ Black, not Hispanic or Latino
   ☐ Native Hawaiian or Other Pacific Islander, not Hispanic or Latino
   ☐ White, not Hispanic or Latino
   ☐ Two or more races, not Hispanic or Latino

2. What is your age? ______

3. What is your degree?

   ☐ Aerospace Engineering
   ☐ Biological Engineering
   ☐ Biomedical Engineering
   ☐ Chemical Engineering
   ☐ Civil Engineering
   ☐ Computer Engineering
   ☐ Computer Science
   ☐ Construction Engineering
   ☐ Electrical Engineering
   ☐ Environmental Engineering
   ☐ Industrial Engineering
   ☐ Materials Science and Engineering
   ☐ Mechanical Engineering
   ☐ Mechanical Engineering Systems
   ☐ Mechatronics Engineering
   ☐ Nuclear Engineering
   ☐ Paper Science and Engineering
   ☐ Textile Engineering

Appendix B

Undergraduate Women's Engineering Experiences Interview Protocol

1. Tell me about yourself. For example, where are you from, what's your major, what do you enjoy doing?
2. In twenty years, imagine you are featured in a magazine about women. What would your article say? What are your history and your future especially in regard to engineering?
3. Describe to me your favorite experiences during your engineering degree. What is the story surrounding that experience?
    a. What about your least favorite experience during your engineering degree? What is the story surrounding that experience?
4. What has been your most enjoyable engineering course? What happened that made it enjoyable?
    a. What has been your least enjoyable engineering course? What happened that made it less enjoyable?
5. Tell me about a time you felt pride during your engineering degree.
    a. In contrast, tell me a story about a time when you felt disparaged during your engineering degree.
6. Describe to me a time when you felt ready and prepared for something in your engineering program.
    a. Describe to me a time when you felt underprepared for something in your engineering program.
7. Tell me a story to illustrate what it is like to be a female engineering student at NC State.
    a. Has your gender ever been significant in your experience? How so?
    b. Was there ever a time you felt your gender was an advantage? What happened?
    c. Same question but switch "advantage" with "impediment. What happened?
8. In what ways do your faculty advance your success in engineering?
    a. In what ways do your faculty stymie your success in engineering?
9. Describe how your degree program fosters your success in engineering.
    a. Describe how your degree program impedes your success in engineering.
10. In what ways does the College of Engineering cultivate your success in engineering?
    a. In what ways does the College of Engineering hamper your success in engineering?
11. Tell me a story about how NC State champions your success in engineering.
    a. Tell me a story about how NC State deters your success in engineering?
12. Is there anything else you would like to discuss?

Appendix C

Member Check Qualtrics Survey

Thank you for your participation in my dissertation research. I was able to speak with eleven different women in aerospace engineering, biomedical engineering, chemical engineering, computer science, industrial engineering, mechanical engineering, and nuclear engineering. The following four themes represent all of the discussions: engineering and social justice; imposter syndrome; growth mindset; and sexism. As a result, please indicate whether or not the theme is representative of your experiences. Everything may not apply to you. You will also have an optional opportunity to respond or elaborate on each item. Depending on your responses, this survey may take you as little as five minutes. Your participation in this survey is voluntary and your responses are completely confidential. You may contact me with any questions or concerns at ajdinin@ncsu.edu.

Theme 1: Engineering and Social Justice

The women told stories about engineering and social justice in two ways: 1. to recruit more women into engineering, and 2. to use engineering for communal goals, or to do good.

1. Does part 1 of this theme represent your experience (you enact efforts to recruit more women into engineering)?
    1=Yes
    2=Maybe
    3=No
2. Does part 2 of this theme represent your experience (you have used engineering to improve the world/lives of others or you plan to use engineering to improve the world/lives of others)?
    1=Yes
    2=Maybe
    3=No
3. Elaborate on your response to theme one or provide additional thoughts or feedback here.

Theme 2: Imposter Syndrome

Through the imposter syndrome or phenomenon, people believe that they are imposters, "that they lack qualities of intelligence and competence, despite objective evidence to the contrary" (Simmons, 2016, p. 119). The women told stories questioning their abilities on multiple levels: about assignments, about classes, and about their majors overall—whether they were cut out for their majors or if they should have even been accepted into the major in the first place. Stories of this self-doubt are akin to the imposter syndrome.

4. Does this theme represent your experience?

1=Yes
2=Maybe
3=No

5. Elaborate on your response to theme two or provide additional thoughts or feedback here.

Theme 3: Growth Mindset

Students who have a growth mindset, "believe that their abilities can be developed" and are at an advantage as opposed to students with a fixed mindset, or the belief that one's "intelligence or math and science ability is simply a fixed trait" (p. 2; Dweck, 1999). To combat biases and feeling like an imposter, participants told stories demonstrating how they employed a growth mindset. The women explained that they were more determined, worked harder, and were more involved than their male counterparts. They illustrated examples of strategies to overcome adversity, especially when failing an assignment or even a class.

6. Does this theme represent your experience?
   1=Yes
   2=Maybe
   3=No
7. Elaborate on your response to theme three or provide additional thoughts or feedback here.

Theme 4: Sexism

All of the participants told stories illustrating implicit bias (the attitudes or stereotypes that affect our understanding, actions, and decisions in an unconscious manner) from their male classmates. In group work, the women were the only females in their groups and their opinions, suggestions and work were often discredited. The engineering major of the participants affected whether this discrimination continued beyond their early, introductory engineering coursework. Some of the participants also told stories of explicit bias (the attitudes and beliefs we have about a person or group on a conscious level), sexual harassment or assault.

8. Does the theme of implicit bias represent your experience?
   1=Yes
   2=Maybe
   3=No
9. Does the theme of explicit bias represent your experience?
   1=Yes
   2=Maybe
   3=No

10. Elaborate on your response to theme four or provide additional thoughts or feedback here.

Thank you for your participation. Please advance the survey to submit your responses. You may contact me with any questions at ajdinin@ncsu.edu.

Appendix D

LEARN Model Interview Protocol

1. What artifact did you bring with you to represent your past? Please tell me about it.
2. Describe the point in time when you decided to pursue a degree in engineering.
3. Tell me about a time where you doubted pursuing a degree in engineering.
    a. What did you learn from this experience?
    b. How have you persisted in engineering in spite of this challenge?
4. Pre-college experiences have been attributed to women's underrepresentation in engineering, for example, a lack of rigorous k-12 coursework in science or math, or insufficient academic advisement in high school to pursue engineering, or even not knowing anyone, especially any women, in engineering careers. Can you tell me a story about one or two of those pre-college experiences that affected your decision to pursue engineering?
5. Social norms have also been attributed to women's underrepresentation in engineering, such as, the lack of flexibility of an engineering career to get married and have a family, or that engineering is for White men. What are your opinions on these social norms?
    a. Have you had any experiences that can illustrate these societal issues? If so, please tell me about them.
6. What artifact did you bring with you to represent your present? Please tell me about it.
7. In what ways do you think about your engineering ability?
8. How would you rate your overall ability in college and in engineering?
    a. Why did you choose to rate yourself in such a way? Can you tell me a story that backs-up your rating?
    b. Tell me about a time that you received recognition for your performance in engineering.
        i. Can you think of any times when you did not receive recognition when you thought you should have or you would have liked to—what happened?
        ii. In what ways do you identify as an engineer?
9. What aspects of your own identities (e.g. gender, race, nationality, ethnicity, or sexual orientation) do you think have influenced your experience in pursuing engineering? Note, that these identities may not have influenced your experience, but, if they did, will you tell me a story that demonstrates this influence?
10. What are your goals for after graduation?
    a. Describe how your goals have changed over time and why your goals may have changed.
    b. What strategic perspectives or actions do you take to pursue your goals? Can you tell me about a particular time when you chose to take on a certain

mindset or chose to do something specifically with the intention of meeting your goals?

   c. During the course of the engineering program, what have you learned about yourself, your goals, and the environment (whether that be at NC State or the engineering field in general)?
   d. How do you make decisions about your goals for after graduation?

11. What artifact did you bring with you to represent your future? Please tell me about it.
12. What do you expect to happen after graduation? Will you get a job at an engineering firm? Will you go to graduate school?
    a. What informs this expectation (i.e., your own experiences or the experiences of someone else)?
    b. How do you envision (future role) will be?
       i. What are some of the benefits or disadvantages you expect from role?
       ii. What challenges do you expect to face in your future role? Why do you expect to face these challenges?
13. Is there anything else you would like to discuss in regard to your engineering trajectory?