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Women in Engineering: The Impact of the College Internship on Persistence into an Engineering Field

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WOMEN IN ENGINEERING:

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ABSTRACT

The development of a diverse engineering workforce, with a variety of skills and interests is essential to the future of American innovation. Historically, the engineering field has been grounded in a series of standards that often benefit men while creating barriers for women. Thus, strategies for overcoming barriers to women's successful transition into an engineering field are critical. Professional internships serve as a means to socialize students into the field of practice that they will enter. This study explored whether or not there are differences in how women and men perceive the professional internship; in particular as it relates to overcoming existing barriers to acquiring a job in the field. This study employed quantitative methods for data collection and analysis. A survey was administered to former interns in the Langley Aerospace Research Student Scholars program (LARSS) who interned between 2001 and 2011. The sample for the first question, looking at student perceptions of internship elements, was 162 former LARSS interns, 40 women and 122 men. The sample for the second question, comparing the 21st Century Skills needed in the field to their development in the internship, was 109 former LARSS interns, 27 women and 82 men. All participants completed a survey through NASA Langley Research Center. Results for question one suggest gender differences on interns' perceptions of mentoring and the research project, finding that men rated each of these factors higher than women. For question two, no gender differences were found on any of the 20 skills assessed; however the internship did not adequately prepare students for the field in 17 of the skills. This study concluded that differences do exist among men and women in their perceptions of the professional internship, but that a simplistic dichotomy between how men and women approach engineering is no longer accurate. Women engineering students are interested in both technical and psychosocial aspects of the engineering internship and emphasis on a wider continuum of behavior is needed in academia and industry. Future internships should be developed to support both the social and technical aspects of engineering and the establishment of intentionally constructed partnerships between higher education and industry that provide students with support, feedback, and opportunities to be involved in the field.

Keywords: internships, engineering, women, 21st Century Skills

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Chapter 1: Introduction

The needs for an engineering workforce for the 21^{st} century are well documented (Burke & Mattis, 2007; Casey, 2012; Dalton, 2004; Dohn, Pepper, & Sandgren, 2005; Fantz, Siller, & DeMiranda, 2011; S. Res. 1459, 2011; National Academy of Sciences, 2005). Demand is increasing in many fields of engineering including biomedical, electrical, aerospace, computer, automotive, environmental, and mechanical (Gearon, 2012). This growth is especially keen in the areas of research and development, with research into new technology, pharmaceuticals, and energy, as well as in industry, with growth in automation and robotics (Gearon, 2012). Even in 2009, in the middle of the economic downturn when the national unemployment rate was 8.6%, the rate for engineering was 4.5% (Identified, 2011). In 2011, the unemployment rate for engineers was down to 2.3 (NSF, 2012, Table 3-8). It is projected that U.S. companies between 2008 and 2018 will experience an 11% rate of growth and the decreasing unemployment rate suggests that this growth is well underway (NSF, 2012). However, the supply of American engineering graduates is not keeping up with the demand (Identified, 2011). Concerns abound over America's downward trend in graduating college educated engineers (Freeman, 2006; Heckel, 2008; Spellings, 2006), the lack of interest in engineering academic programs (Grose, 2006; NSF, 2012), and the high number of engineering graduates choosing to work in non-engineering fields (Carnevale, Smith, & Melton, 2011; Casey, 2012; Langdon, McKittrick, Beede, Khan, & Doms, 2011; NCES, 2012).

Engineering Graduation Rates

International statistics and trends suggest that America is falling behind in the number of engineering degrees awarded annually (Burke & Mattis, 2007; Freeman, 2006; Heckel, 2008). The number of engineering students graduating with a bachelor's degree is on the decline, from 75,031 in 2002 to 69,908 in 2008 (see Table 1; NSF, 2002, Table 2-32; NSF, 2008, Table 2-32). Although attrition among undergraduate engineering students is not unlike the attrition rate in other majors (Ohland, Sheppard, Lichtenstein, Chachra, & Layton, 2008), American engineering programs are not producing enough engineers to successfully compete against developing countries like China, where engineering graduate numbers are on the rise (Burke, 2007; Freeman, 2006). Of the total number of undergraduate engineering degrees awarded internationally to students aged 24 or younger in 2002, the United States accounted for 10.9% of them (Heckel, 2008). Asia accounted for over 50% and Europe nearly 30% (Heckel, 2008). The numbers in Asia are projected to continue to climb while those in the United States are on a slow decline (see Table 1; Heckel, 2008).

Table 1.1 *Comparisons of First University Engineering Degrees of Three Regions*

NSF 2-32	USA	EU	Asia
2002	75,031	369,667	635,721
2008	69,908	322,847	1,133,610

Note: From NSF, 2002 and 2008, Table 2-32; First university degree is equivalent to the U.S. bachelor's degree

Among doctoral degrees awarded, 77% are awarded in Asia and Europe and another 20% in the western hemisphere (Heckel, 2008). However, 62.2% of the engineering doctoral degrees awarded in the United States in 2006 were given to foreign national students, many of whom came to the United States specifically to attend graduate school, not to U.S. citizens (Heckel, 2008). Although this number gradually decreased during the recent recession, it remains over 50% (see Table 2; Yoder, 2012). Due largely to immigration and visa issues, many of these students return to their home countries after graduation, taking their training and expertise with them and further reducing the engineering workforce supply in the United States (Grose, 2006; Identified, 2011; Partnership for a New American Economy, Information Technology Industry Council and U.S. Chamber of Commerce, 2012).

Table 1.2 *Foreign National Engineering Doctoral Degree Recipients, 2004-2011*

	2004	2005	2006	2007	2008	2009	2010	2011
Nonresident Alien	57.8	59.4	61.7	61.6	58.3	55.1	54.2	54.2
Permanent Resident	42.2	40.6	38.3	38.4	41.7	44.9	45.8	45.8

*Note: From ASEE *Engineering by the Numbers,* Yoder, 2012. Data presented as a percentage.

Background Factors Influencing Pursuit of Engineering

The problem in the United States regarding engineering education is twofold, on the one hand there are not enough students interested in pursuing a degree in engineering, the percentage of high school seniors intending to pursue an engineering degree remains well under 20% in the United States (NSF, 2012, Table 2-12), leaving a limited pool of candidates who begin engineering programs. On the other hand, there is a leaky pipeline from which many who pursue an engineering degree drop out, particularly between graduation and entering the workforce (Casey, 2012; Carnevale et al., 2011). The combined effect is a shortage of American engineers entering the engineering workforce.

This section reviews several factors that influence the pursuit of an engineering degree including lack of student interest in the topic, demand for engineers in non-engineering careers, the role of women in engineering, and the impact on the workforce.

Lack of Interest

Interest in engineering among high school students remains low; well under 20% of students intend to pursue an engineering degree. One reason for this lack of interest is the dearth of information available to students on engineering careers (Grose, 2006). There are few engineering courses offered in K-12 education and often those engineers who speak to students about engineering careers speak about the rigors of preparation, not the benefits and impact of the occupation (Grose, 2006). From drinking clean water to fuel-efficient vehicles, most of the technological advancements society depends on are the result of an engineering accomplishment, but this is seldom understood by parents, teachers, counselors, or students (Grose, 2006). According to the executive director of the Society of Women Engineers (SWE) Betty Shanahan, "We're the invisible profession. We don't make clear the impact we make in the world" (as cited in Grose, 2006, para. 6). How can student interest develop in engineering when there is so little information available to young people about the profession? The issues of developing interest among high school students are especially pronounced for women who often face multiple barriers internally and externally that deter them from exploring an engineering field (see Table 3; ASEE, 2012; NSF, 2012, Table 2-12).

Table 1.3 *College Freshmen Intending to Major in Engineering by Sex*

	Men	Women
2000	15.9	3.0
2005	15.6	2.6
2010	17.9	4.0

*Note: Adapted from Table 2-12, NSF, 2012; Data presented as a percentage.

The lack of interest among high school students, particularly among girls (as measured by college freshmen in the table above), to pursuing an engineering degree results in minimal exposure to engineering and inadequate preparation in appropriate pre-engineering coursework (Purcell, 2012). Interest in a STEM subject and proficiency in mathematics are necessary for a student to select an engineering major (Business Higher Education Forum, 2010; Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011). Many girls will choose not to take challenging math and science courses in middle school, decreasing their likelihood of reaching advanced math and science courses in high school that best prepare them for an engineering program (Burke & Mattis, 2007). Additionally, activities such as engineering camps, engineering courses, and enrichment activities in engineering all help students better understand what engineers do; however, efforts to bring girls into these programs have not resulted in great gains at the undergraduate level thus far (Blickenstaff, 2005). The combination of inadequate preparation and minimal exposure to engineering concepts keep many potential future engineers out of the engineering pipeline and challenge others who attempt an engineering program to persist through it.

Demand for Engineers in Non-Engineering Fields

Perhaps the greatest area of concern for engineering in the United States is the high number of American engineering graduates who choose occupations outside of engineering. According to NCES (2012), of the engineering graduates in 2008, just over one third were employed in engineering, less than one third were working in other STEM fields, and just over a third were employed in non-STEM fields. Looking beyond this cohort, the trend continues. According to the U.S. Department of Commerce, of the 3,706,000 engineering graduates employed in 2009, only 1,083,000 were employed as

Table 1.4 *Engineering Degree vs. Engineering Occupation in 2009*

	Total	Total STEM	Computer	Math	Engineering	Physical/ Life Sciences	Non-STEM degree
Total	41,530	9,262	1,359	646	3,706	3,551	32,268
STEM employment	4,736	3,327	763	167	1,738	659	1,409
Computer and math	2,167	1,331	637	120	447	128	835
Engineering	1,444	1,225	39	19	1,083	85	219
Physical/Life Sciences	654	484	8	9	54	413	170
STEM manager	471	287	80	19	155	33	184
Non-STEM employment	36,794	5,935	595	479	1,968	2,892	30,859

* Note: From U.S. Department of Commerce: Langdon et al., 2011. Employed persons presented in the thousands.

engineers (Langdon et al., 2011). Another 655,000 were working in other STEM jobs, but 1,968,000 were working in non-STEM jobs (see Table 4; Langdon et al., 2011). What contributes to those staying in engineering programs and careers?

There is an increasing call for STEM qualified workers in business and other non-STEM professions (Carnevale et al., 2011; Casey, 2012; Identified, 2011). The current state of demand for engineers has been documented by low unemployment rates and continued job shortages in engineering (Gearon, 2012; Identified, 2011; NSF, 2012). But if there are engineering positions available, why are so many graduates choosing careers outside of engineering? Non-STEM professionals, such as those in finance, business, and health care suggest there is a lack of adequately prepared employees who have these critical thinking, technical, and professional skills and thus they are turning to engineering students to meet their needs (Carnevale et al., 2011; Casey, 2012; Lichtenstein, Loshbaugh, Claar, Chen, Jackson, & Sheppard, 2009). Almost all non-STEM professions require math skills, but American 15 year olds' scores on international testing place the United States statistically below the OECD average in math (Fornash, 2010). Finding employees with strong math skills is increasingly difficult in non-STEM sectors (Jobs for the Future, 2007).

The compatibility of engineering and other professional careers is in part due to the alignment between the standards set by ABET for engineering programs and the 21st Century Workforce Skills defined by business and industry (ABET, 2011; Casner-Lotto & Barrington, 2006; Pinelli & Hall, 2012). Additionally, non-STEM professions often offer more incentives over time than an engineering profession, including higher pay potential and a greater work-home balance (Burke, 2007; Carnevale et al., 2011; Casey, 2012). In contrast, personnel hiring engineers in industry suggest that engineering students are often prepared by engineering faculty who have never worked in industry and therefore are not fully preparing students for industry work (National Academy of

Engineering, 2005). They find that these students are underprepared for the business and industrial engineering workforce in which 85% of them will work (NAE, 2005). Thus, graduates can choose between a non-STEM career in which they are seen as well prepared or an engineering career in which they are considered underprepared. Combined with the benefits of shorter hours, a better work/life balance (Fouad & Singh, 2011) and the potential for higher pay (Carnevale et al., 2011), the allure of non-STEM careers becomes increasingly evident. Whatever the reason, the high number of engineering graduates choosing careers outside of engineering creates a challenge within the engineering workforce that calls for a new approach within both higher education and industry (Casey, 2012; Langdon et al., 2011; Lichtenstein et al., 2009)

Women

Making up more than half of the United States' population and holding the majority in undergraduate higher education nationwide (NCES, 2012), women are underrepresented in both academic engineering programs and the engineering workforce (Adelman, 1998; ASEE, 2012; Fouad and Singh, 2011; Grose, 2006; Purcell, 2012; Seymour & Hewitt, 1997). Although more women are choosing engineering than in the past (Yoder, 2012), the ratio of men to women remains highly skewed toward men, who make up 80% of the undergraduate engineering student body (Yoder, 2012). Moving into the field, the situation worsens, with men holding 89% of the engineering positions in the field (Fouad & Singh, 2011). Often statistics for women engineers are combined with other STEM fields. For instance, unemployment rates for women engineers and architects are higher than for men, but exactly what the statistics are for women is unknown (Bureau of Labor Statistics, 2012).

The problem of women's success in engineering is not a deficit on the part of women. The gender gap in math has closed and there are no statistical differences between the academic success of women and men on SATs or in AP courses (Drew, 2011; Felder et al., 1995; Seymour & Hewitt, 1997). And yet, in spite of entering engineering academic programs as well prepared as men and demonstrating a high level of confidence and motivation, women are more likely to struggle in the engineering program (Felder et al., 1995; Marra & Bogue, 2006; Seymour & Hewitt, 1997). Why?

What women face, often for the first time, when they enter an engineering program is a "social system which has been traditionally all-male" (Seymour & Hewitt, 1997, p. 255). The trademarks of this system are seen in multiple dualisms, including the mind (rational)/body (emotional; Robinson & McIlwee, 1991), technical/social (Faulkner, 2007), and competitive/collaborative (Chesler & Chesler, 2002). For each of these dualisms, the first attribute is considered masculine and is prized in the engineering culture, and the second is considered feminine, and is considered inferior. In such a setting, power, authority, and success are determined by a set of standards that align to the highly skewed standards of what is the most rational, technical, and competitive. Such a setting creates challenges for all those who do not conform to these standards, and among these non-conformists are women.

Stereotypes about men and women are prevalent in the engineering culture. These stereotypes suggest that men are autonomous, with instrumental abilities (Gilligan, 1993). They are motivated by being challenged, they are competitive, and they favor individual achievement (Chesler & Chesler, 2002). Women on the other hand are connected to others, with expressive abilities (Gilligan, 1993). They are motivated through encouragement, they are collaborative, and they view success as affiliation within a group (Chesler & Chesler, 2002). The challenge in engineering is to break these stereotypes and recognize that engineering requires both sets of skills; that these skill sets are not dichotomous, but equally important to the success of an engineer (Faulkner, 2007).

Engineering has been male-dominated since its establishment as a field. Children have been socialized to see engineering as a field for men from a young age (Bystydzienski & Brown, 2012). Bringing about change requires institutional commitment from academia and the workforce. Multiple barriers must be overcome to increase women's access and success in engineering programs and careers, chief among them are institutional changes that support women in engineering programs and provide them with access to the field long before their college graduation.

The factors affecting the success of women becoming engineers are many and complex, including academic preparation; encouragement from parents, teachers, and school counselors; access to accurate information about engineering careers, the abilities of the student, the support provided through academic advising and quality teaching, and experience in the field (Burke & Mattis, 2007; Chubin, May, & Babco,, 2005; Grose, 2006; Marra, Rodgers, Shen, & Bogue., 2012). The impact of these factors begins long before the student enters higher education and continues beyond the completion of a bachelor's degree. The challenge facing higher education is no longer that of identifying the barriers to persistence in engineering, but rather it is in determining how best to overcome them.

Impact on the Workforce

What do the decreasing number of engineering graduates, the lack of interest high school students have for engineering, and the large number of engineering graduates working in non-engineering professions mean for American engineering employers? Fewer American engineers translate to employers looking beyond the borders of the United States to meet labor needs. Many engineering employers have been hiring internationally trained engineers to fill their needs, chief among them companies like Microsoft, Google, and IBM (Geron, 2011; Identified, 2011). Although not the only visa for foreign engineers, the H-1B Specialty Occupations Visa was designed in part to meet the needs of the engineering workforce by allowing foreign engineers to enter the country to work for up to six years (NSF, 2002; United States Citizenship & Immigration Services, 2011). But dependence on foreign engineers leads to challenges for employers when these employees with specialized skills must return to their country, taking their knowledge and skills back with them. Historically, there were many immigrants, particularly from developing countries, who came to work in the United States (Mattis, 2007). However, as visa regulations since 9-11 have become more restrictive and many developing nations have made significant advancements, fewer foreign engineers are coming to America for work (Mattis, 2007; Jobs for the Future, 2007). The importance of building up an American engineering workforce cannot be overstated.

In order to build a strong American engineering workforce, multiple efforts must be made, some in K-12 education, others in higher education, and still others within the workforce. Currently, engineering is dominated by white males (Adelman, 1998; Burke & Mattis, 2007; Carnevale, 2011; Casey, 2012; Grose, 2006; Seymour & Hewitt, 1997). One way to not only increase the number of engineers in the workforce, but also to create a more diversified and representative workforce is to increase the number of women and underrepresented minorities in engineering (Burke & Mattis, 2007; Carnevale, 2011; Casey, 2012; Grose, 2006). Although both populations share many commonalities related to engineering, they are each unique enough to merit their own attention. As such, this study will focus on women in engineering.

Persistence

Persistence and completion in higher education has been a focus of study for decades. Tinto's (1975) early dropout model pointed to the interactions between the individual and the academic and social systems of the college. Students who are able to integrate into the academic and social systems are more likely to persist at the college or university (Tinto, 1975). Tinto (1982) clarified that his model was intended to draw attention to the impact the institution has on dropout behavior, both in its formal and informal constructs. From a policy perspective, Tinto (1982) asks how institutions should change to better meet the needs of their students and improve persistence. Recently, Tinto and Pusser (2006) created a model of institutional action for improving persistence and success in higher education (see Figure 1). The model is intended to help institutions move from awareness of persistence theories to active change. Focusing on students once they arrive at the institution, this model looks at the impact of institutional commitment on the creation of a climate of expectation, in which all students are empowered to succeed (Tinto & Pusser, 2006). At its core is a triad of support, involvement, and feedback, all three interwoven and all three impacting the student's learning, the quality of the student's effort, and the student's success. This model provides a guide for engineering schools seeking to increase persistence, particularly among women.

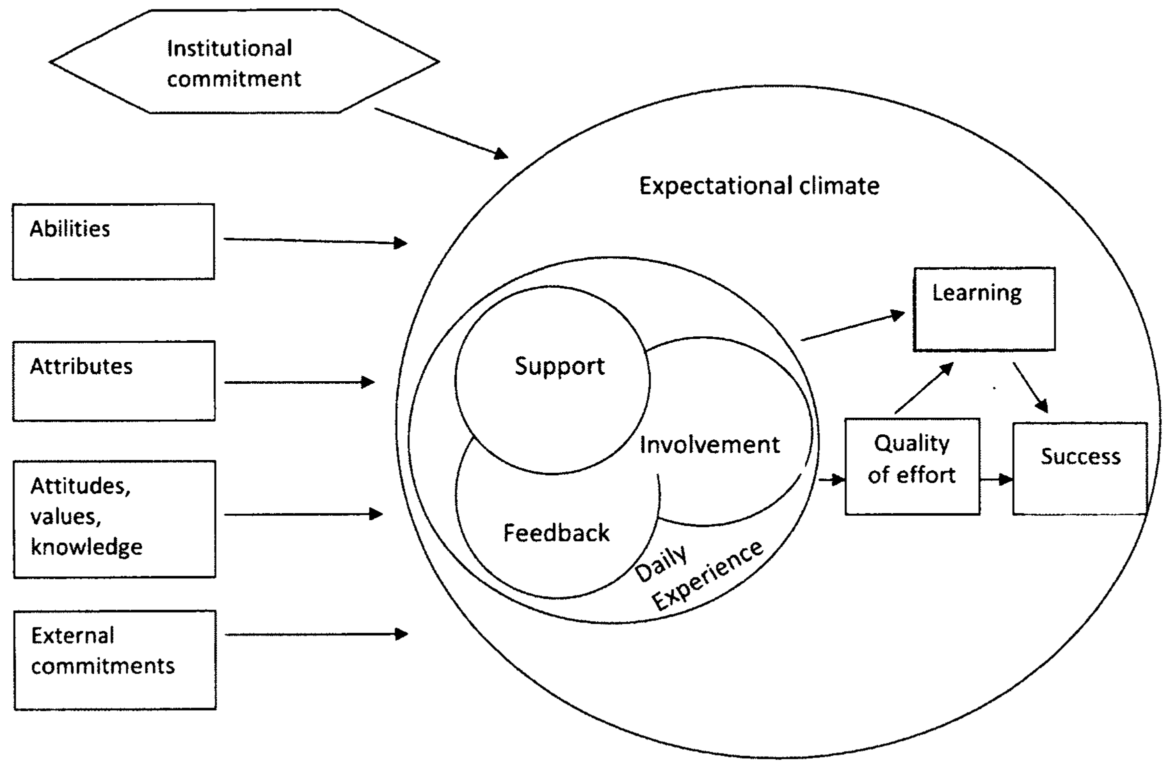

Figure 1.1: Tinto & Pusser's (2006) Structure of a Preliminary Model of Institutional Action

Problem Statement

"If a team of three engineers all look alike and think alike, then there are two people on that team that are not needed" (Anderson-Rowland et al., 1999, p. 7). In a global economy, it is essential that the field of engineering diversify to ensure that it is meeting the needs of the diverse population it serves. There are multiple obstacles to diversification, some internal, others external. All of these have been discussed, debated, and explored, but primarily from a theoretical perspective. Less research exists on effective strategies for overcoming the low persistence of women in engineering programs. An action plan that institutions can initiate to overcome these barriers and increase student persistence is needed (Tinto & Pusser, 2006).

One institutional intervention that has proven effective in increasing persistence into the field is the internship experience (Anderson-Rowland et al., 1999; Kardash, 2000). Internships help students identify what engineering is and what it is not; allowing them to enter the workforce as a temporary member, apply the skills learned in the classroom and learn how to function in the field (Ciot & Ciot, 2010; Croissant et al., 2000; Lichtenstein et al., 2009; Ruiz et al., 1999; Wright et al., 2007). Internships assist students in overcoming the internal and external barriers that stand between them and a successful engineering career. But developing an effective internship program requires consideration of multiple factors. The elements of an internship are varied, and can include a multiple week experience with a single mentor and/or a multiple week experience on a research team, as well as networking opportunities, presentations, lectures, and site tours (Croissant et al., 2000; Ruiz et al., 1999; Wright et al., 2007). Skills covered can also be varied, and some skill sets may prove more valuable than others. Often cited skills include professional, technical, and leadership skills (Haag, Guilbeau, & Goble, 2006; Ruiz et al., 1999; Wright et al., 2007). However, the elements and skills of an internship that are best for men in engineering may not provide adequate support to overcome the barriers that exist for women in these programs. If the number of women in the engineering workforce is going to improve, then institutions must consider the needs of women as they develop their academic programs, particularly their professional internship experiences.

Research Question

To determine the ideal elements of an engineering internship for women, it is important to determine if men and women benefit from the internship in the same way. The primary research question for this study was:

Is there a difference in how women and men perceive the professional internship? Within this question were two sub-questions:

1. What elements of the internship are perceived by women as most important in preparing women for a profession in engineering as compared to those that are perceived by men as most important to preparing men?
2. What skills are developed in the internship that support women's persistence into an engineering profession as compared to the skills that support men's persistence?

Purpose

Using Tinto and Pusser's (2006) model as a conceptual framework, the purpose of this study was to determine whether or not there is a difference between women's and men's perceptions of the professional internship in overcoming barriers in pursuit of an engineering degree and preparing them for the workforce, focusing particularly on the components of the internship and the skills developed during the internship that contribute to persistence into the engineering profession. Research suggests that internships may play a role in retaining students in engineering programs by providing realistic hands-on experiences and a chance to apply knowledge and skills learned in the classroom (Plouff, 2011). In an internship, students combine the theory from the classroom with the reality of the field (National Association of Colleges and Employers, 2012). In the process, they build a network of peers and mentors who can support them through not only the internship, but also the early stages of their career. In addition, the internship provides students the opportunity to develop confidence, experience, and a social identity in the field. But not all internships are constructed the same nor are they experienced in the same manner by students. Although nearly all internships include a mentor, only some include networking, presentations, technical report writing, working on a research team, or a curriculum component (Croissant et al., 2000; Kardash, 2000; Ruiz et al., 1999; Wright et al., 2007). What remains unknown is whether or not women benefit from the same aspects of the internship as men, and if not, what is most important for them in order to overcome existent barriers and persist into the workforce.

Significance

Pinelli and Hall (2012) call for research on the role of the internship on college persistence based on their study of partnerships between industry and higher education. This study answers that call. Due to the limited information available on internship designs for women and the limited sample size, this study is considered exploratory. The results of this study could inform future studies on internship development, helping to define the critical components of internships for women. These could include opportunities for networking, providing mentors of the same gender, multiple internships, and placement on team-based, rather than isolated projects. Exploring the key components of internships for women in engineering programs will pave the way for further studies on the development of institutional action plans that meet the needs of diverse populations. The impact of the internship on persistence will be based in part on the successful design of the experience, the levels of support made available, and the ability of the student to put into practice what she has learned in the classroom. This study opens the door for further exploration of internship designs that support diverse populations in engineering.

Operational Definitions

21st Century Skills –Basic knowledge and applied skills required to succeed in the 21st century workplace. Basic knowledge includes English language (spoken and written), reading comprehension, mathematics, science, government/economics, humanities/arts, foreign languages, and history/geography skills. These skills tend to come from the basic high school and liberal arts curriculum (Casner-Lotto & Barrington, 2006). Applied skills include critical thinking/problem solving, oral and written communication, teamwork/collaboration, diversity, information technology application, leadership, creativity/innovation, lifelong learning/self direction, professionalism/work ethic, and ethics/social responsibility (Casner-Lotto & Barrington, 2006; Pinelli & Hall, 2012).

ABET – Formerly called the Accreditation Board for Engineering and Technology, ABET is the accrediting body that accredits engineering (among other) programs in higher education institutions around the world. ABET's student outcomes (often presented as 3a-k) refer to the skills and abilities students should have acquired before graduation from an accredited program. These skills for 2012 include: (a) the ability to apply knowledge; (b) the ability to design and conduct experiments and analyze and interpret data; (c) the ability to design within realistic constraints; (d) the ability to function in a multidisciplinary team; (e) the ability to identify and solve problems in engineering; (f) an understanding of professional and ethical responsibilities; (g) the ability to communicate effectively; (h) a broad knowledge base and an understanding of the impact of engineering solutions in a broader context; (i) recognition of the need for and ability to engage in life-long learning; (j) knowledge of contemporary issues; and (k) the ability to use engineering techniques, skills, and tools (ABET, 2011).

Internship – "An internship is a form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skills development in a professional setting. Internships give students the opportunity to gain valuable applied experience and make connections in professional fields they are considering for career paths; and give employers the opportunity to guide and evaluate talent" (NACE, 2012, "Definition," para. #2).

Model of institutional action – Tinto and Pusser's model for moving from student persistence theory to institutional action for increasing student persistence in higher education (Tinto & Pusser, 2006).

Persistence - "The enrollment of individuals over time that may or may not be continuous and may or may not result in degree completion" (Tinto & Pusser, 2006, p. 1).

Success - Completion of an undergraduate degree (Tinto & Pusser, 2006).

Study Design

The following chapters answer questions about the impact of an internship on overcoming barriers to persistence, particularly for women, and identify the attributes of an internship that are most valuable for women. Chapter two focuses on the literature that exists on persistence among women as well as literature on internships and institutional action. Chapter three presents the methodology to be used in the study. Chapter four presents the results of the analysis and chapter five provides a discussion about the theoretical, practical and political implications of the results.

Summary

The purpose of this study was to determine whether or not there is a difference between women's and men's perceptions of the professional internship in overcoming barriers in pursuit of an engineering degree and preparing them for the workforce. In particular, this study sought to determine if there are specific elements of the internship, such as networking opportunities, site tours, and technical writing opportunities that are particularly important in preparing women for the engineering workforce as well as certain skills that are developed in the internship that support women's persistence into an engineering profession. For institutions developing internship programs, recognizing the needs of women in an internship could improve persistence and success rates of women moving through engineering programs into engineering careers.

Chapter 2: Literature Review

The question guiding this dissertation research asked if there is a difference in how women and men perceive the professional internship, both in terms of the components of the internship and the skills developed during the internship. The culture of engineering creates numerous obstacles for women that are reinforced by society and that create barriers to women's success in the field (Bystydzienski & Brown, 2012; de Pillis & de Pillis, 2008; Dohn et al., 2005; Faulkner, 2007; Mau, 2003; Robinson & McIlwee, 1991; Seymour & Hewitt; 1997). If the number of women in the engineering workforce is going to increase, then institutions must consider the needs of women as they develop their academic programs (de Pillis & de Pillis, 2008; Vogt, 2008), particularly as they create and improve their professional internship experiences. The focus of this literature review is threefold. The first section provides an overview of persistence of women in engineering programs, including a review of the internal and external barriers that exist for women in engineering programs. Next is an explanation of the attributes of a quality internship and how the internship helps women to overcome existing barriers. Finally, the chapter ends with the theoretical framework and the use of this lens for the current study.

Persistence in Engineering

College persistence and program persistence have been the topic of numerous studies over the last several decades (French, Immekus, & Oakes, 2005; Griffith, 2010; Jackson, Gardner, & Sullivan, 1993; Price, 2010; Scaefers, Epperson, & Nauta, 1997; Tinto, 1975; Tinto, 1982; Tinto & Pusser, 2006). Historically, persistence has been referred to in both negative terms, such as dropout, student disengagement, institutional departure, and attrition, and positive terms, including persistence, retention, and success (Tinto, 1982; Tinto & Pusser, 2006). For the purposes of this discussion, the terms persistence and success will be used to describe the phenomenon of students continuing in an academic program and completing it, respectively. Persistence is defined as "the enrollment of individuals over time that may or may not be continuous and may or may not result in degree completion" and success as the completion of a degree (Tinto & Pusser, 2006, p. 1). The reasons some students succeed and others do not depend on a variety of factors, including institutional obstacles, personal and cultural barriers, and varying levels of individual commitment (Tinto, 1975; Tinto, 1982).

The search for a better understanding of the variables leading to success resulted in the development of Tinto's (1975) dropout model. This model suggests that there are attributes, experiences, and family background characteristics that play a part in determining who will drop out and who will persist in a higher education program. Factors of persistence include sex, race, grade point average (GPA), pre-collegiate experiences, motivation, self-efficacy, ability, aptitude, support, values, and interest (French et al., 2005; Schaefers et al., 1997; Tinto, 1975; Tinto & Pusser, 2006). Some of these attributes and experiences will lead to persistence, and others will lead to drop-out. Tinto (1975) determined the student's "integration into the academic and social systems of the college most directly relates to his continuance in that college" (p. 96). Positive experiences, both academic and social, lead to integration in the academic and social systems of the institution and increase commitment to the institution and/or program, resulting in degree completion (Tinto, 1975). It is part of the institution's responsibility to encourage persistence through the creation of an environment where a diverse body of students can have positive academic and social experiences (Tinto, 1975). But what does this mean for women?

Looking at multiple factors of persistence for women, Schaefers et al. (1997) found that academic ability measures are best at predicting women's persistence in engineering majors, in particular first semester GPA. Other statistically significant factors that influence persistence are math and science self-efficacy, external support, and the congruence between interest and choice of engineering as a major (Schaefers et al., 1997). French et al. (2005) also found that college GPA is a significant predictor of persistence, as is motivation, and that pre-college variables such as SAT math scores and high school rank are significant in predicting college GPA among engineering students. For institutions to increase the graduation rate of their female engineering students, they must consider these factors in the development of their academic programs.

Persistence in higher education has been well studied for decades, theories have been tested and models developed. There are academic and social issues that must be addressed in an institution to maximize student success. Looking at women in engineering specifically, there are predictors of persistence that have been identified, such as academic success, self-efficacy, interest, access to external support, and motivation (French et al., 2005; Schaefers et al., 1997). However, many of these factors can also be seen as barriers to women, jeopardizing the likelihood of their success.

Barriers for Women in Engineering

Carnevale, Smith, and Melton (2011) identified a series of competencies necessary for success in a STEM field, some cognitive and others non-cognitive. Cognitive competencies include knowledge, skills, and abilities while non-cognitive competencies include interests and values (Carnevale et al., 2011). Together, these five competencies provide the student with what she needs to progress through an academic program into an engineering career. However, many women do not have access to materials and information about engineering, restricting their development within these competencies (Burke & Mattis, 2007; Seymour & Hewitt, 1998). For these women, internal and external barriers prevent the full development of the competencies that enable the student to succeed in an engineering program. These barriers include a lack of intrinsic interest, low self-efficacy in engineering and engineering-related skills, lack of access to engineering preparation courses, lack of support within engineering programs, and a male-dominant culture in engineering (Burke & Mattis, 2007; Seymour & Hewitt, 1998).

Internal barriers

Internal barriers to persistence into an engineering career include a lack of intrinsic interest in engineering and low self-efficacy. The greatest predictor of success in engineering is intrinsic interest in engineering (Hall et al., 2011; Seymour & Hewitt, 1997). A strong interest in engineering helps students overcome the challenges to persistence in the field; however, this intrinsic interest can only be had through exposure to and an understanding of engineering (Seymour & Hewitt, 1997), something many women lack (Adelman, 1998; Hirsch, Kimmel, Rockland, & Bloom, 2006). Young women are less often socialized to tinker and participate in gaming activities, activities that build pre-engineering skills, putting them behind in the learning of experiential engineering concepts before they even begin an engineering program (Cech, Rubineau, Silbey, & Seron, 2011).

Seymour and Hewitt (1997) found that women pursuing engineering often come to it because of extrinsic motivations, such as the influence of parents or teachers, not intrinsic reasons like a strong interest in the field. These extrinsic motivators are often not enough of a motivation to overcome the challenges of the engineering program (Seymour & Hewitt, 1997). However, exposing young women to engineering before college can increase the likelihood of pursuing an engineering degree (Dohn et al., 2005; Gilbride et al., 1999). The challenge is finding programs that focus specifically on engineering, not science (Goodman, et al., 2002). Gilbride, Kennedy, Waalen, and Zywno (1999) found that 76% of high school senior females who attended the Discover Engineering camp as high school seniors said it significantly increased their understanding of what engineering is and 60% went on to pursue engineering degrees, claiming that the camp experience was a factor in their decision making. Opportunities such as these can have a positive impact on all students, but especially on women who lack the exposure and an understanding of engineering.

But developing an intrinsic interest before college is only half of the battle. Students entering introductory engineering courses are faced with a fast paced barrage of theory that is often difficult to understand, especially for those who lack hands-on experience which can support their burgeoning understanding of engineering's abstract concepts (Dohn et al., 2005). Weed-out courses, designed not to develop interest, but rather to weed students out of the program are especially challenging for women (Dohn et al., 2005; Seymour & Hewitt; 1997). These classes are large, impersonal, competitive, and fast-paced (Felder, Felder, Mauney, Hamrin, & Dietz, 1995). The teaching style of these engineering courses does not align to the typical learning style of women, which is more collaborative and less competitive (Felder et al., 1995). These courses contribute to a loss of interest, which 49.5% of engineering students who left their engineering programs cited as the reason for switching majors (Seymour & Hewitt, 1997). The structure of weed-out courses was cited by 60% of the women who left engineering as a factor in their decision to switch or as a concern about their program (Seymour & Hewitt, 1997). The combination of lack of prior exposure to engineering and these weeding-out courses, which reduce interest in engineering instead of enhancing it, have a negative impact on women's interest in the field, which leads to lower levels of persistence (Seymour & Hewitt, 1997). Identifying ways to enhance women's interests in engineering instead of diminishing it needs to be a consideration of engineering programs that wish to increase the number of women engineers that graduate and move into an engineering field.

Self-efficacy is another important internal motivation for persistence. Self-efficacy refers to one's belief in her own abilities to succeed in a specific situation. Bandura (1997) identified four sources of self-efficacy: mastery experiences, social persuasions, physiological states, and vicarious experiences. As an individual experiences success, she becomes more confident and as she experiences failure, she loses confidence (Bandura, 1997). Mastery experiences are most important for self-efficacy in general, but vicarious experiences are more important for those individuals who have little to no experience in a specific area (Bandura, 1997).

Hutchison-Green, Follman, and Bodner (2008) point to the importance of confidence in one's own abilities toward success in an engineering field. They found that incoming male and female students were very confident in their future engineering success based on their previous mastery experiences. However, high school performance is a poor predictor of success in an engineering program (Seymour & Hewitt, 1997), and three months into their first engineering course, these students were relying on vicarious experiences to judge their self efficacy; comparing themselves to their peers, not to their past performance (Hutchison-Green et al., 2008). In spite of the fact these men and women were experiencing mastery, they no longer saw their success as based on their performance on specific tasks; rather they evaluated themselves based on a comparison between their own abilities and the abilities they perceived in their peers (Hutchison-Green et al., 2008). For women, this shift from a focus on mastery to vicarious experiences resulted in a loss of self-efficacy, as compared to men, who experienced an increase in self-efficacy (Hutchison-Green et al., 2008). When discussing influences on self-efficacy, men tend to focus on their positive experiences while women focus on their negative experiences, seeing each failure as a challenge to the development of self-efficacy (Hutchison-Green et al., 2008). This helps to explain why women in their freshman year suffer a drop in self-confidence, increasing the likelihood that they will switch out of the engineering program (Brainard & Carlin, 1998).

Self-efficacy in mathematics is a significant predictor of persistence in engineering, but self-efficacy in mathematics is often not as strong in women as it is in men (Mau, 2003). Women demonstrate a lack of confidence in their own mathematical and analytical abilities (Hall, Brush, & Pinelli, in review). In a survey of interns and their mentors, female interns rated their computational and analytical thinking skills significantly lower than their male counterparts (Hall et al., in review). Mentors, however, did not rate females significantly lower in either area, suggesting that women have comparable math abilities to men, but women have lower confidence in their mathematical abilities. Indeed, the gender gap in high school math has nearly disappeared (Hyde & Linn, 2006), which should even the playing field in terms of preparation for engineering programs. In fact, however, women who left engineering majors were found to have lower self-confidence ratings than those who stayed, in spite of holding the same GPA (Brainard & Carlin, 1998).

Taken together, these internal barriers create hurdles that many women must overcome before they can succeed in an engineering program. Lack of intrinsic interest and low self-efficacy both contribute to women's attrition from engineering programs. These factors are experienced differently by most men in engineering, for whom an intrinsic interest is usually present and whose self-efficacy is developed based on their successes, not their failures (Adelman, 1998; Seymour & Hewitt, 1997). But internal barriers do not exist alone. Embedded within and weaving through these internal barriers are external and cultural barriers that often have a compounding negative impact on women's persistence in engineering.

External barriers

External barriers for women in engineering include those related to access and support. For women to successfully navigate higher education's engineering programs, they must be encouraged to enter them and be supported within them (Chubin et al., 2005; Felder et al., 1994; Marra et al., 2012). Finding this type of support is particularly challenging because of the gender inequalities in the field (Robinson & McIlwee, 1991).

In spite of higher overall academic achievement than men, women intending to enter engineering in high school are less likely to do so than men who decided to pursue engineering in high school (Adelman, 1998). The gender gap in high school math and science has nearly vanished and boys and girls in K-12 are similarly matched in both of these skill sets (Baine, 2012; Hyde & Linn, 2006). The only remaining significant difference in high school is that boys have higher complex problem-solving skills, but this difference is small (Hyde & Linn, 2006). For women who are in engineering, there is little difference between their academic preparedness and that of men in engineering (Marra et al., 2012; Seymour & Hewitt, 1997). However, stereotypes that girls are weaker in mathematics and science abound (Hyde & Linn, 2006), and these stereotypes often drive teachers, counselors, and parents to push girls away from challenging mathematics and science programs (Grose, 2006; Seymour & Hewitt, 1997), and even deter college admissions officers from admitting women into engineering programs (Hyde & Linn, 2006).

Educators, counselors, and parents lack information about engineering and are often unable to advise students about an engineering career as a result (Goodman et al., 2002; Hirsch et al., 2006). Efforts are needed to educate these populations on the career options and opportunities available in engineering (Anderson-Rowland et al., 1999). For example, participation in rigorous pre-engineering classes in middle and high school is correlated to higher self-efficacy in engineering among male and female college freshmen (Fantz et al., 2011), yet engineering is not taught in the typical middle or high school curriculum (Anderson-Rowland et al., 1999). By educating leaders and teachers in K-12 education on the importance of such classes to future engineering students, improvements can be made. This outcome is evidenced in the state of North Carolina, which, after years of effort from multiple stakeholders in engineering, has recently adopted the North Carolina Engineering Connections, designed to introduce engineering concepts into the K-12 curriculum (E. Parry, personal communication, December 18, 2012). As long as educational leaders and teachers are uninformed, stereotypes will continue to persist that work against women's access to engineering degree programs. And without access, there can be no success.

In higher education, increasing the number of women in engineering requires attention not only to what is being taught, but also to who is teaching (Abriola & Davies, 2006; Chubin, et al., 2005; Hall et al., in review; Felder et al., 1995; Sonnert, Fox, & Adkins, 2007). With moderate numbers of American women pursuing advanced degrees in engineering, the pool of female candidates available for engineering faculty positions is low (Felder et al., 1995; Yoder, 2012). In 2011, female tenure track faculty in engineering schools represented 13.8% of faculty (Yoder, 2012). This small representation of women faculty in engineering programs suggests that as students go into an engineering program, women are less likely to take courses from professors of their gender than men. Research argues that gender matching of faculty and students matters in persistence and success (Sonnert et al., 2007).

Many women entering an engineering degree program have had limited exposure to engineers and their first exposure to a social group of engineers may be the faculty at their university. Female faculty members can provide a different level of support for female students trying to succeed in a male dominated profession; providing mentorship to students who see them as evidence that people like them can become engineers (Abriola & Davies, 2006; Burke, 2007; Nelson, 2007; Seymour & Hewitt, 1997). These mentors serve as role models, providing information not only on the field, but on how a person in their shared social group can successfully negotiate within the field (Burke, 2007; Felder et al., 1995; Nelson, 2007).

Female faculty members provide support in multiple forms, but the impact they have on persistence is unclear. Women faculty are perceived by students as using more varied teaching techniques, being more approachable when students need clarification, and creating an egalitarian atmosphere, more so than their male counterparts (Seymour & Hewitt, 1997). The presence of female faculty is associated with higher numbers of and more positive outcomes for female students, including success in the completion of a degree (Sonnert et al., 2007). However, there is also research to suggest that having a female professor has little to no impact on female persistence (Price, 2010). Price (2010) found that for women, having a female professor increased the likelihood of persistence by only 1.1% and that was only true in the first semester, after which there was no impact. Carell, Page, and West (2010) looked at a sample of students who had been randomly assigned to male and female professors. They found that female students perform significantly better in math and science courses that are taught by female professors; however this did not impact the female's likelihood to persist through the program. In spite of this contradictory evidence for persistence, the benefit of female professors for women in engineering who can serve as mentors and social advocates is of great value to female engineering students and results in gains academically or socially in all the studies identified.

External barriers to women's persistence compound the internal challenges facing them, negatively influencing their levels of access to and support in an engineering • program. But perhaps the greatest obstacle to success is larger than the internal or external barriers; it is the culture and climate of engineering education, a culture that is competitive and exclusive.

Climate/culture

The culture of engineering is a "socially defined standard of behavior and interaction among engineers" (Robinson & McIlwee, 1991, p. 403). This culture is focused on the value of technology, specifically in being a producer of technology; it values the accumulation of organizational power as a measure of success, and it requires male forms of interaction, including aggression, competition, and hands-on competence (Robinson & McIlwee, 1991). It is no surprise, therefore, that within this culture of engineering, there is a "culture of exclusion" in which only the best can succeed (Drew, 2011, p. 107). This exclusive culture consists of courses designed to weed-out students, put up barriers to their success, and present a large amount of information in a short period of time (Blickenstaff, 2005; Drew, 2011; Marra et al., 2012; Seymour & Hewitt, 1997).

The atmosphere of engineering programs is often one of competition, not collaboration, deterring students from asking questions and seeking support, for fear of being seen as inadequate (Drew, 2011; Seymour & Hewitt, 1997). Interestingly, in the field, collaboration is often essential between various engineers, mathematicians, scientists, and technologists. The stigmatism against collaboration that is so evident in the classroom is not as pronounced in the field (Faulkner, 2007), rather the skill is valued.

Concerns with climate include limited interaction with faculty and poor advising (Marra et al., 2012; Seymour & Hewitt, 1997). A poor climate for women may be evidenced in the faculty's lack of engagement or impersonal interactions with students;

and this leads to a lack of persistence (Marra et al., 2012; Seymour & Hewitt, 1997). The dichotomous role that faculty hold, that of gatekeepers, ensuring that only the top students enter the program, and advisors, providing support for students as they need it, make them as much a threat as a potential support (Seymour & Hewitt, 1997). Students turning to faculty for guidance are therefore as likely to be advised to leave the program as they are to be given advice on how to succeed in it (Seymour & Hewitt, 1997).

Competition between students can lead to avoiding student study groups, asking questions, and seeking help that is available for fear of being seen as inadequate (Seymour & Hewitt, 1998). Although this competitive environment exists for all students, it is more debilitating for some than others, and is of particular concern for those who have lower self-efficacy, lack intrinsic interest in the field, and have wondered if they should even be there in the first place (Brainard & Carlin, 1998). These are all issues that apply to women.

Alienation plays a role in women's decision to leave engineering (Adelman, 1998; Seymour & Hewitt, 1997). Engineering is a male dominated and male oriented field (Robinson & McIlwee, 1991). Women face direct discrimination in the form of disparaging comments from faculty and discounting behaviors by their male classmates, and indirect discrimination such as tone of voice, infrequent opportunities to use machinery, and in the way students are referenced as "guys" (Seymour & Hewitt, 1997, p. 245). These behaviors contribute to their tendency to become more passive in courses, even those with a cooperative structure (Felder et al., 1995). Under such conditions of alienation it is not surprising that the persistence rate for women is lower than that of men, 40% as compared to 53% (Price, 2010). Seymour and Hewitt (1997) found that the lack of faculty guidance, through advising, class support, and personal attention plays a role in the attrition rates in STEM fields, and this is especially true in engineering. This finding was confirmed 15 years later by Marra et al. (2012). Why is it that after 15 years, the conversation has not changed?

The competitive nature and broad curriculum of engineering courses work against women, who tend to learn best in cooperative settings through discussion and engagement (Blickenstaff, 2005; Felder et al., 1995), and perform best when there is a focus on depth over breadth (Blickenstaff, 2005). Traditionally, the view of students has been one of open vessels, ready to be filled with new information (Barr & Tagg, 1995). Lectures, chalk/talks, and rote memorization are the trademarks of such an academic system. These techniques are common in the engineering classroom, disadvantaging women whose collaborative learning style prevents them from learning effectively without the opportunity to engage with the ideas and materials of the field (Bernold, Spurlin, & Anson, 2007).

The culture of engineering tends to be less formal, with more ambiguity, largely due to the fast pace of innovation and the nature of the unstructured problems engineers traditionally solve (Robinson & McIlwee, 1991). Thus, engineering programs are more aligned to a survival of the fittest ideology, giving power to those who aggressively seek it (Adelman, 1998; Robinson & McIlwee, 1991). This competitive structure favors men, who are more aggressive than women (Hyde & Linn, 2006). To increase the number of women in STEM, Blickenstaff (2005) recommends that courses be designed that include cooperative groups and which increase the depth of material covered, not just the breadth, especially in introductory courses. Improving the number of women in engineering requires movement away from the dichotomous either/or culture of the field. It requires an acknowledgement of the importance of social interaction and collaboration in the field – attributes that are essential to the engineering workforce, even if they are not favored.

Summary

The preceding barriers to women's persistence create a complex matrix for women to travel through with challenges that range from developing intrinsic interest and self-efficacy to accessing an engineering program and finding supportive role models, to feeling accepted in a traditionally male dominated field. The barriers to persistence for women engineering students are presented here separately, as internal, external, and cultural. However, in reality, these overlap, creating a web of barriers that is difficult to break through without paradigmatic changes to the structure of engineering education. For example, faculty interaction with students has an impact on student academic self-regulation, achievement, self perception of competence and self-efficacy, particularly for women (Vogt, 2008). Faculty members who can reinforce self-efficacy in their students are more likely to see an increase in the number of students who persist through their engineering programs (Vogt, 2008). The critical challenge is this: engineering faculty members know they have a retention problem among female students, but what to do about it is another matter (Astin & Astin, 1993; Seymour & Hewitt, 1997; Vogt, 2008).

The development of a system-wide action plan is key to overcoming the high levels of attrition among women in engineering programs. Change must occur at the faculty level, the institutional level, and within the discipline of engineering. Vogt (2008) suggested that faculty members begin with small changes, showing an interest in students, becoming more approachable, and more personable. At the same time there is a growing movement in engineering schools to move to a learner-centered approach to education (Barr & Tagg, 1995), one that focuses more attention on retention and success for all students (Bernold et al., 2007; NAE, 2005). New curricular approaches that incorporate ill-structured problems, more similar to those experienced in the workforce, could help students better prepare for the engineering workforce and clarify early in their programs what types of challenges and opportunities engineers experience (Jonassen, 2006). Programs that incorporate field work, mentors, internships and a variety of resources for students are most likely to succeed (Bernold et al., 2007; Drew, 2011). Finally, as a discipline, engineering needs to reconsider the weed-out approach traditionally adopted in engineering programs and support engineering faculty in creating a new image, one that supports students and encourages them to succeed, not to drop out (Drew, 2011). At every level of change, interventions must be considered for the broad engineering population, based on similarities across genders (French et al., 2005; Schaefers et al., 1997), but also specifically for women, to encourage and support a desperately needed workforce of women in engineering (Schaefers et al., 1997). One technique that reaches across multiple levels of the institution and across men and women is the professional college internship, where students are supported in the field by faculty, administrators, and professionals in business, government, and industry.

Internships

Authentic learning provides students opportunities to learn by solving real-world problems (Lombardi & Oblinger, 2007). In authentic learning activities, students are enculturated into the discipline before they complete their academic programs (Lave & Wenger, 2003). One example of an authentic learning experience is the internship. More and more students are participating in internships as an increasing number of colleges and universities promote internship opportunities and businesses and industries support them (National Association of Colleges and Employers (NACE), 2012). Internships can provide women with the opportunity to integrate theory with practice through authentic learning, meet practicing professionals, experience the challenges and joys of an engineering career, find the value of engineering work, experience professional accountability structures, and develop work habits and interest in a field (Ciot & Ciot, 2010; Lombardi & Oblinger, 2007; Stevens, O'Connor, & Garrison, 2005; Watkins, Ochs, & Snyder, 2003). All of these opportunities support the transition from academia to the profession (Ciot & Ciot, 2010). But which elements an internship should include, what the purpose should be, and what function it holds are ill-defined in the overall engineering degree program (NACE, 2012).

A clear definition of the term internship was recently developed by the National Association of Colleges and Employers (NACE) in 2011 (NACE, 2012). The criteria for an internship include transferable skills and knowledge, a defined beginning and end for the internship, a job description with qualifications, clear learning objectives or goals connecting professional goals to academic coursework, supervision by a professional, routine feedback from the supervisor, and a setting that supports the learning objectives (NACE, 2012). For the academic institution, effective internships depend on institutional commitment to aligning the curriculum and internship experience, improving advising for students, and building students' engineering self-efficacy before they enter the field (NACE, 2012; NAP, 2005). Appropriate standards for measuring the quality of the internship (Wright et al., 2007) and formative evaluation of the program that is dynamic, resulting in adjustments and changes, are also important for the creation of effective internships (Ciot & Ciot, 2010; Hall et al., in review).

Engineering today requires the ability to work on multidisciplinary teams, develop strong technical skills, and improve upon a variety of professional skills (Doel, 2009). Of particular focus are soft skills, including communication skills and teamwork (Doel, 2009) and these skills are strengthened through authentic learning experiences (Lombardi & Oblinger, 2007). In the internship, students are expected to apply these soft skills in their work; however, these skills are often not well taught in the engineering academic program (Doel, 2009; Hall et al., in review). Responsibility, time management, oral communication, and collaboration are a few of these critical skills that students learn in the workplace more successfully than the traditional engineering curriculum (Hall et al., in review; Moulton & Lowe, 2005). The questions remains, however, as to which skill sets are most beneficial to women as compared to men.

Standards

The Accreditation Board for Engineering and Technology, formerly called ABET, has defined specific skill sets that all accredited engineering programs should include. Among them are analytical skills, problem solving and decision making skills, project management, teamwork, and research processes (Lattuca, Terenzini, & Volkwein, 2006; Wright et al., 2007). The National Academy of Science recommends that ABET criteria be used in the development of engineering curriculum to ensure that academic programs adequately prepare students for engineering careers in the future (NAP, 2012). The ABET skills are highlighted in research and multiple reports on engineering internships (Haag et al., 2006; Pinelli & Hall, 2012; Lattuca et al., 2006; Wright et al., 2007).

Arizona State University used the ABET Criterion 3 Student Outcomes standards to develop an assessment for their internship programs that includes questions about several key competencies for engineers (Haag et al., 2006). Among these are foundations in mathematics and basic engineering, abilities in design systems, professionalism, the ability to work in multidisciplinary teams, oral and written communication, life-long learning, and knowledge of current issues in the discipline and in society at large, all of which align to the ABET standards (Haag et al., 2006; Lattuca et al., 2006).

Wright et al. (2007) applied the ABET criteria to evaluate a biomedical engineering summer internship through a list of six critical elements in an internship: research skills, clinical experience, communication, tours and demonstrations, social activities and didactic classes where students learn about safety, procedures, and how to manage current issues in the field. Through these elements students develop technical expertise, problem solving skills, and knowledge of their own abilities and interests, all of which align to the ABET standards, and result in students more prepared for a future career in engineering (Lattuca et al., 2006).

Other studies speak to important elements of an internship, many of which parallel the ABET standards for successful internships. For instance, Davis (2010), reflecting on his high school engineering internship experience, identified oral and written communication, hands-on experience in the field, career guidance (formal or informal), and mentoring as critical elements of the internship. Another example is the University of Nevada at Las Vegas entertainment engineering internship that focuses on close ties to the curriculum, assigning mentors, and requiring a technical write-up and presentation by each intern (Dohn et al., 2005). Finally, the ASU bioengineering internship also includes coursework that ties the work in the field to previous coursework, requiring report writing, presentations, and development of an internship portfolio (Haag et al., 2006). Students in an aviation internship attested to the importance of working with people in the field and experiencing the work environment and 80% reported that the internship had a great or significant impact on their careers (Ruiz et al., 1999). All of these are examples of carefully developed internship programs, designed to meet the varied needs of students.

The ABET standards and the above standards created for student internship experiences all align with what are often called "21st century workforce skills," the skills necessary to succeed in the modern business and industrial workforce (Pinelli & Hall, 2012). The 21st century workforce skills were initially developed by the 21st Century Workforce Commission established in 1999, and include academic, thinking, reasoning, technical, and collaborative skills (21st Century Workforce Commission, 2000). In 2002, the Partnership for 21st Century Skills (P21) was developed, bringing together representatives from business, education, and government to place these skills at the forefront in K-12 education and society as a whole (P21, 2004). This partnership continues to outline the skills and knowledge that college graduates should have as they enter the workforce.

Standards are important to any discipline, but one set of standards may not be ideal for all students. It is important to assess the standards that are held for engineering to determine if they meet the needs of diverse populations. One way to determine this is to assess the skills needed for a career in an engineering field and compare it to the skills acquired in school or in an internship experience.

Institutional commitment

For engineering internships to be most effective, the internship should be part of a broader institutional plan to improve engineering education. "Too many efforts at reform attempt to look at single elements of complex interconnected systems. We believe that entire systems must be considered, even if a narrower focus is ultimately taken" (NAP, 2005, p. 17). This institutional plan will be influenced by the discipline, through professional societies, the institution, including administration and governing bodies, the faculty at all levels of leadership, and the students (NAP, 2005).

One example of a successful systems approach is in the efforts to attract and retain women in engineering at Tufts University (Abriola & Davies, 2006). Tufts' commitment to women faculty and students permeates not only the School of Engineering, but the entire campus. It begins with administrative leadership at multiple levels. The university administrators have held a commitment to women for over 20 years, sponsoring programs for girls and undergraduate women and recruiting female faculty and administrators (Abriola & Davies, 2006). The School of Engineering at the time of publication had a strong female dean who was very involved in faculty hiring and creating structural supports for faculty and students (Abriola & Davies, 2006). Under her deanship, women were depicted in recruitment and advertising materials about the school, gender was considered in admissions decisions, and a variety of scholarships and programs were available to support women when they arrived at the School of Engineering. All of these institutional measures create an inviting and supportive environment for female engineering students.

A significant strength to Tufts approach to increasing the access and success of female engineering students is the interdisciplinary nature of academic programs within the institution (Abriola & Davies, 2006). Although engineering students have less flexibility in their schedules, they are encouraged to take classes from the School of Arts and Sciences and many are able to complete double majors between the two schools. This flexibility reduces the isolation found in many engineering programs (Abriola & Davies, 2006).

Mentoring and advising are also important at Tufts, with a particular focus on providing "concrete role models of women in Engineering" (Abriola & Davies, 2006, p. 13). Professional staffs are assigned to arrange and supervise student internships, providing individualized attention to students as they explore their options.

This systemic commitment to women has had a significant impact on the percentage of women attending Tufts engineering program, 30% of the freshmen engineering class in 2006 were women, as well as on those who succeed, ranging from 26% to 39% over a seven year period, significantly higher than the national average for women, which was between 18% and 21% (Abriola & Davies, 2006).

The Tufts example demonstrates the element of institutional commitment in Tinto and Pusser's (2006) model as the university's program supports students via feedback from faculty and peers, and involvement across the college campus and into the field (Abriola & Davies, 2006). These institutional tactics have resulted in an increase in the number of women who enter and complete the engineering program.

Institutions that are committed to the success of their students are more likely to seek out quality, respected internship opportunities for their students, rather than requiring their students to find internships on their own. Such institutions may look to public internship rankings as a source of information on the quality of an internship (Vault, 2013). Faculty members that are familiar with quality internship opportunities are more likely to recommend them to their students. But are faculty members as likely to recommend these internships to their female students as they are to their male students?

Evaluation

Finally, a quality internship program requires evaluation of both the students and the mentors to determine what was most effective and what changes should be made in the future as well as what skills were developed over the course of the experience (Ciot & Ciot, 2010; Hall et al., in review). Mentors evaluation of students should be based on skill development, professional behavior, and autonomy while students' evaluation of mentors should include quality of mentoring, the value of what was learned, the quality of the internship environment, the supports provided and personal development (Ciot & Ciot, 2010). To determine the overall value of the internship program and ensure that it is meeting the needs of the students, the university, and the business or industry, the university should also evaluate internship programs more broadly, looking at student performance, what activities were done in the internship, overall communication between the university, student and industry, and host company feedback (Ciot & Ciot, 2010). Such an evaluation provides opportunities to assess the strengths of the curriculum, student learning outcomes, and the ever changing needs of the field (Haag et al., 2006). Using these types of data, from students, mentors, industry, and the university, a system can be developed for revising educational goals and objectives as the needs of the future engineering workforce are altered due to new innovation and technology and as new information on how students learn becomes available (NAP, 2005). Above all, it must be ensured that the internship is a learning experience for the student, not just a work experience the student completes (NACE, 2012).

Summary

One aspect of engineering education that has been demonstrated to improve persistence in engineering is authentic learning experiences; for the purpose of this paper, the focus is on the professional college internship. Internships developed following the standards set by ABET and by the Partnership for 21st Century Skills will ensure the alignment between engineering education and the engineering workforce. Institutional commitment to the internship requires commitment at multiple levels of the institution and beyond. Ensuring that advising and teaching are valued as highly as research will support the development of strong educational programs that prepare students for internships and later, the field. Finally, dynamic evaluations that assess the state of engineering education and make changes accordingly are necessary to ensure that the goals and objectives of engineering programs can adapt to the needs of an evolving workforce (NAP, 2005). One of the critical goals of engineering education should be to support underrepresented populations, including women, in overcoming the barriers that jeopardize their persistence and success. Internships provide one mechanism for meeting this objective.

Overcoming Barriers to Persistence through Authentic Learning

Authentic learning provides students the opportunity to think like an engineer, work like an engineer, and through this doing learn what it means to be an engineer (Glenn, 2010). Working on authentic engineering projects helps students understand the multidisciplinary nature of the field (Glenn, 2010), as they work on teams with various types of engineers, scientists, mathematicians, and technologists. Learning by doing provides motivation, clarification, and a deeper understanding of the culture within the field (Lombardi & Oblinger, 2007). The goal of authentic learning is to learn how to be an engineer, not about engineering competencies (Lombardi & Oblinger, 2007).

"Authentic learning typically focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice" (Lombardi & Oblinger, 2007, p. 2). In this learning experience, students learn about content as it is applied to a complex, ill-structured problem; in the process learning multiple perspectives, how to work with people from other fields, communication, and flexibility (Lombardi & Oblinger, 2007). Beginning authentic learning experiences early in the academic program increases the likelihood of success for students as they learn how to be an engineer by completing engineering tasks in an environment that reflects the real-life complexity of the field (Watkins, Ochs, & Snyder, 2003).

As students continue through their academic preparation, they experience authentic learning through college internships. The college internship provides engineering students an opportunity to engage in the field and apply the theory learned in the classroom to the actual workplace (Ciot & Ciot, 2010; NAP, 2005). For women who have not had previous authentic learning experiences in engineering, this opportunity to enter the field of engineering can be critical, as it may be one of the first times that they are able to learn about the specific fields of engineering, about opportunities in engineering, and about an engineering topic of interest (Goodman et al., 2002). The college internship, as it relates to women as compared to men, is the focus of this study.

Most programs that offer internships do so in the junior or senior year of the engineering program. However, by this point, many women have already left their programs (Brainard & Carlin, 1998; Goodman et al., 2002). The most significant periods of student attrition from engineering programs are the first and second years (Brainard & Carlin, 1998; Goodman et al., 2002). Historically, attrition throughout higher education, both programmatically and institutionally, has been highest in the freshman year, due to a variety of social and cognitive factors, as students discover that the reality of college life is inconsistent with their expectations (Tinto, 1982). For engineering students, the freshman year has traditionally been a time when students take weed-out courses (Drew, 2011; Seymour & Hewitt, 1997) that may result in these students changing majors, but not necessarily withdrawing from the college. The history of these student outcomes has focused attention on ways to change the curriculum during the first years of an engineering program. Instead of the focus on weed-out courses, the first years of college for engineering students would be better served with authentic learning activities that include hands on, team exercises highlighting the social relevance of engineering through the solving of real world problems and teaching students what engineers do by engaging in real activities for authentic purposes (NAP, 2005; Ohland et al., 2003). Such experiences better prepare students for future college internships, which can begin as early as the freshman year.

Overcoming Internal Challenges

Internships provide the opportunity for students to immerse themselves in a field of potential interest, developing intrinsic interest and self-efficacy in the field, and gathering insight into possible career paths for the future (Bandura, 1997; Ciot & Ciot, 2010; Drew, 2011; Stevens et al., 2005; Wright et al., 2007). It is in doing the real thing that many students gain interest in their chosen engineering field (Madill et al., 2007; Chanson, 2004; Glenn, 2010; Lombardi & Oblinger, 2007; Watkins et al., 2003), and the internship provides the opportunity to more fully discover all that the field has to offer. In the internship, the student can explore a career, identify where she fits in, and develop a realistic expectation of what an engineering career is and is not (Pinelli & Hall, 2012; Stevens et al., 2005). Internships allow students the opportunity to experience the daily activities of an engineering career, determine their interests in the field, and make connections to their classroom learning.

"Early exposure to the design, build, and test process that marks the practice of engineering" is important for increasing persistence (NAP, 2005, p. 42). The earlier in the academic program that women are introduced to engineering concepts, design, and problem solving through engineering to serve society, the more likely they are to persist (NAP, 2005). Completion of an undergraduate research experience during the freshman or sophomore year could provide such exposure in the field, just as women are being introduced to engineering as an area of study. There are internship programs designed for freshmen and sophomores, in addition to juniors and seniors, the program of this current study being one of them. In such programs measures are taken to ensure that freshmen and sophomores are paired with mentors or peers who can provide additional support for the less experienced student (C. Brown, personal correspondence, July 11, 2012). However, internships during the freshman and sophomore years must be approached with caution.

On the one hand, it is never too early to experience the field, as evidenced by Davis (2010), who successfully completed a high school engineering internship. The benefits of his experience were profound in developing his understanding of engineering as a field, acquiring problem solving, critical thinking and communication skills, learning how to use lab equipment, and accessing career guidance and support. For sophomore women in Brainard and Carlin's (1998) study, participation in an internship increased persistence; as did working and the development of a relationship with an advisor. These reports tie into Tinto and Pusser's (2006) model, demonstrating the value of support, involvement, and feedback in the internship. These students found support, both academic and social; became involved and integrated into the engineering community; and received feedback, through interaction with experimentation in their work and those they were working with, all of which strengthen persistence and motivation to succeed (Brainard & Carlin, 1998; Davis, 2010; Tinto & Pusser, 2006).

On the other hand, for students who lack self-efficacy, an internship too early may push them further away from a career in engineering, as they learn from vicarious experiences how much they do not know (Bandura, 1997). This is particularly true of women, for whom the shift from mastery to vicarious experiences results in a loss of self-efficacy and who see each failure as a threat to their own ability (Hutchison-Green et al., 2008). Yet, there is conflicting evidence on what influences self-efficacy (Zeldin & Pajares, 2000). Zeldin and Pajares (2000) found that women's self-efficacy beliefs are based on vicarious experiences watching their role models succeed, as well as verbal encouragement. Opportunities to interact with supervisors who are supportive, both male and female, was another positive influence for women engineers (Zeldin & Pajares, 2000). These people were reported to provide motivation, encouragement, and confidence to the women. Internships during the freshmen and sophomore years may be appropriate for some women, but such decisions must be made with caution to ensure that the experience does not push the student away from engineering instead of drawing her toward it.

Junior and senior years are more common for internships. By this time, the student has enough knowledge to understand the theory behind what is happening in the field, and, ideally, enough understanding to choose a direction to pursue in an engineering field. However, even at this point in the student's program, depending on the internship, she may be motivated toward continued studies in engineering, or she may discover that engineering is not what she expected and decide to follow a different path (Lichtenstein et al., 2009). If this internship is the only experience a student has in the field before choosing whether or not to pursue a career in engineering, then it is all the more important that the internship be carefully constructed to meet the specifications of NACE (2012). The intern should not be in an environment where she is simply crunching numbers on a computer, or completing menial tasks while the professionals do the engineering. She is there to learn, not to provide cheap labor (NACE, 2012).

What remains unknown about women's participation in engineering internships is what elements of the internship are most important to them. Would women benefit most from consistent interaction with one mentor or from participation on a research team?

Are women more likely to persist if there are networking events scheduled within the internship, providing opportunities to interact with students and professionals with similar interests?

Because of the complex relationship between the barriers to persistence, one internship is not likely to be enough for students to learn all that they need to know about the field and make sound judgments on their future as engineers (Lichtenstein et al., 2009). Engineering internships can occur at various times during the undergraduate program, and ideally would occur at multiple times to maximize the benefits both socially and technically. Goodman et al. (2002) found that 87.2% of women who had participated in an internship or research experience said they would definitely do it again and 63.4% of women who had not participated in an internship said they definitely would if given the opportunity. Only 0.6% of women who had participated in an internship said they would definitely not do it again (Goodman et al., 2002). Internship experiences across the undergraduate years provide students at multiple stages the opportunity to develop interest, skills, networks of support, and career guidance. Otherwise, generalizations will be made based on only one experience in the field. Unless the faculty and field mentors are able to introduce the student to a variety of engineering experiences and provide the necessary balance of support and challenge to the student, she is likely to make rash judgments on limited information, and these decisions may not lead to her persistence in engineering..

Participating in an internship provides women an opportunity to develop an intrinsic interest in the field as they observe and work with practicing professional engineers (Ciot & Ciot, 2010). Here students develop and expand on their identity as an engineer and build confidence in their engineering abilities (Do, Zhao, Trytten, & Lowe, 2006). As they apply the knowledge and skills from the classroom in authentic learning contexts, they develop confidence in themselves and can begin to develop a professional identity in the field (Cech, Runineau, Silbey, & Seron, 2011; Pinelli & Hall, 2012). However, the internship experience can be highly influential in guiding women toward or away from a profession in engineering (Lichtenstein et al., 2009), therefore it is critical that the internship be carefully constructed to overcome internal barriers for all students, recognizing that the needs of some social groups may be different from the needs of others. What remains unknown is what structures best support women's success and whether or not these are the same as those that best support men.

Overcoming External Challenge

External challenges to women's persistence in engineering include access and support. A well designed engineering internship can help students as they overcome these challenges. The development of quality internships requires institutional commitment and leadership, the development of an "expectational climate" in which students are expected to succeed, and support available from multiple sources (Tinto & Pusser, 2006, p. 12). In such an environment, quality engineering internships are likely to develop, based on the criteria from NACE (2012) and incorporating the skills recommended by ABET and the Partnership for 21st Century Skills .

Often the barriers to access for women to engineering programs and careers are found in K-12 education, where various gatekeepers discourage women from pursuing an engineering degree in direct and indirect ways. How can a professional college internship combat this issue of access? The Teamed Internships Program (TIP) is a collaboration between the University of Arizona and Pima Community College that incorporates educating high school teachers as a component of the internship (Croissant, Ogden, & Ogden, 2000). This 12 week internship provides opportunities for students to work with high school teachers in a summer short course doing experiments, touring laboratories and industrial sites, and discussing the field, curricular materials, and career counseling strategies (Croissant et al., 2000). The program received strong positive qualitative feedback from high school teachers as to its applicability to their work with students (Croissant et al., 2000). Although this question reaches beyond the limits of the current study, the incorporation of a teacher component is worthy of future study.

Women seeking support, particularly from fellow women, may find more support from women in industry, depending on their area of focus, than in academia. Although the numbers in each setting are similar (approximately 13% in academia and 11% in industry), the carefully developed internship has the flexibility to place students with a mentor or supervisor of the same gender, while the students in the classroom are often limited by the low number of female professors and their lack of control over professor's course assignments (Carell et al., 2009). Working with industry partners, however, may provide more flexibility to assign students to mentors of the same gender. For example, the NASA Langley Research Center employs over 200 female engineers. Although this is less than a quarter of the engineers at NASA Langley, it is a large enough number that more women are likely to work with female mentors or on research teams with female engineers. What remains to be determined is whether or not these gender pairings are critical to the persistence of female interns.

For women, a sense of community and relationship is important to overcoming barriers, and in the internship, even if the mentor is not a woman, the intern can be paired with other female students, creating a dynamic support network where women are providing each other with the positive affirmations that are most likely to increase their persistence (Goodman et al., 2002; Zeldin & Pajares, 2000). Women in mathematics-related fields, including engineering, suggest that if more women were in these fields to serve as role models, providing encouragement and mentoring, then other women might be able to see themselves in mathematics-related careers (Zeldin & Pajares, 2000). This encouragement can come from mentors in the field or fellow interns, experiencing the same obstacles and overcoming them together. To facilitate relationships between engineers and interns, internships such as the one of focus for this study arrange networking opportunities where students come together informally with mentors and fellow interns with a focus on relationship building. The significance of these experiences, particularly for women, is a focus of this study.

Overcoming Culture/Climate

The culture of engineering fosters a culture of exclusion, one of competition and a broad, technology driven curriculum (Robinson & McIlwee, 1991). Internships alone cannot fully compensate for this culture, but it is suggested that the best way to promote authentic learning in engineering is through apprenticeships; intensive work with an expert in the field on real, relevant tasks (Kardash, 2000). Such an environment is often more cooperative, integrated, and supportive of the young engineer (Felder et al., 1995; Kardash, 2000). The industries hosting interns are looking to build their own future workforce, and thus they are usually invested in the success of their interns (Ciot & Ciot, 2010; Dalton, 2004). Are certain aspects of an internship more important than others in overcoming cultural barriers for women? Does participation on a collaborative research team increase the likelihood of persistence into the field? These questions are central to the current study.

The creation of an expectational climate in both the academic and internship settings is particularly important for engineering schools, whose climate has been described as exclusionary, particularly for women (Drew, 2011; Marra et al., 2012; Seymour & Hewitt, 1997). An expectational climate is reflected in the expectations held for students and faculty, focused on building a sense of belonging for all students (Tinto & Pusser, 2006). Faculty who are engaging with students communicate to the students that they are important, that their membership in the program is valued (Goodman et al., 2002). This in turn increases the likelihood of persistence (Brown, Morning, & Watkins, 2005; Marra et al., 2012; Zeldin & Pajares, 2000). The faculty members often collaborate in the development of internship opportunities that tie into the curriculum and are appropriate for each student (Haag et al., 2006); which demands a deeper relationship with the student than is traditionally seen in engineering programs. The message to the student who is placed in the internship should be that she can succeed in the field, her advisor believes in her, and she is prepared with the necessary skills and abilities. In a recent study of how intern applicants to an internship program at NASA Langley learned of the internship, 15% of applicants cited a professor or advisor as the person who told them about the internship opportunity (Pinelli & Brush, 2012). This number was second only to the number who had a past experience with NASA (Pinelli & Brush, 2012).

Classroom assignments rarely reflect real workplace problems and thus students must enter the field to learn how to solve the technical problems of the workforce (Doel, 2009). It is in the field where much of the authentic learning takes place, and this is invaluable to the developing engineer. Doel (2009) cautions, however, that the unexamined work experience reduces student learning. Forcing students to reflect on their experiences in the field provides them the opportunity to take responsibility for their errors and celebrate their accomplishments (Doel, 2009; Watkins, Ochs, & Snyder, 2003). The internship is about more than experiencing the workforce; it is about the development of a responsible, thoughtful, and motivated engineer.

Summary

Authentic learning in the internship experience is a powerful influence in making decisions about pursuing an engineering career (Lichtenstein et al., 2009), providing motivation for women who struggle with or dislike the coursework in their engineering program and reminding them that the experience of being an engineer is very different from that of being an engineering student (Faulkner, 2007; Goodman et al., 2002). "The ultimate goal of the internship is to improve student learning" (Wright et al., 2007, p. 28). As the collision point between the theory of the classroom and application in the field, the internship enhances the classroom experience and clarifies to the student the possibilities available in the field (Ciot & Ciot, 2010; Dohn et al., 2005). At the same time, students are expanding on their professional knowledge as they obtain practical experience (Do et al., 2006). In an internship, students learn not only the technical skills of the job, but also professional and life skills and how to apply the lessons learned in the classroom to the real world (Ciot & Ciot, 2010; Davis, 2010). Internships may include working with a mentor or research team, opportunities for networking with peers and engineers in the field, tours of various facilities and information sessions on the field in general (Croissant, 2000; Wright et al., 2007). But are all of these equally important? Are some more important than others? When designing internship programs, what factors should be considered? And should they be considered differently for men than women?

Engineering is a male dominated field, with a climate and structure that favors men (Blickenstaff, 2005). For women to succeed in this culture, undergraduate institutions must have a realistic understanding of what they need to support their persistence into an engineering field. One support that exists for women is the professional college internship. In the internship the woman learns not only about the tasks of an engineer, but also how to use the equipment, work on a team, and complete the technical aspects of an engineering career (Ciot & Ciot, 2010; Davis, 2010). But how can an internship be designed to best serve women? What structures should be in place to ensure that she is adequately supported, such that the internship does not push her away, but rather, draws her into the field? What skills are most valuable in preparing her for a career in engineering? How can the internship be designed to provide maximum support for a burgeoning female engineer? The current study seeks to answer these questions.

Conceptual Framework

Tinto and Pusser's (2006) model provides an ideal framework for positioning the internship in the overall structure of the engineering program. Zooming in on the overlapping circles representing support, involvement, and feedback, the internship fits in the interchange between all three, enhancing each and strengthening not only the student's learning, but also her quality of effort and likelihood of success (See Figure 1).

The internship provides support, through collaboration with mentors, role models, and peers engaged in the same process of learning by doing (Hall et al., in review). It provides an opportunity to be truly involved in engineering, interacting with the technological aspects of the field as well as a multi-disciplinary research team of professionals (Doel, 2009). And a well-structured internship provides feedback, through meetings with a mentor or research team, correspondence with the higher education institution, and peers (Ciot & Ciot, 2010). In the internship, the student is able to bring together all that she has learned about theory and see how it applies to the practice in a real world context in which she is expected to be uncertain, to ask questions, and to seek guidance. This internship environment provides a very different culture from that of the engineering academic program.

Identifying how best to structure the internship to provide for female students' support, involvement, and feedback requires careful consideration. The needs of a woman in an internship are not necessarily the same as those of a man. Belenky, Clinchy, Goldberger, and Tarule (1986) suggested that women's learning is connected through their voice, mind, and self. They defined five "epistemological perspectives from which women know and view the world" (p. 15). Procedural knowing refers to a reliance on objective procedures for the acquisition of and communication of knowledge (Belenky et al., 1986). Within procedural knowing are two approaches, separate knowing, in which the learner is separated from the issue being learned and is where the learner often experiences doubt; and connected knowing, in which truth is acquired through personal experience, not outside authorities (Belenky et al., 1986). The search for connected knowing leads women to seek out relationships with their peers and faculty members, which is often a challenge in the competitive academic engineering environment (Seymour & Hewitt, 1997). Connected teaching provides an opportunity for students to interact with the information and one another to build knowledge (Belenky et al., 1986). This type of interaction is often seen in the relationships between students and mentors.

Exactly where the focus of the female engineer's internship should be is currently not known. She may need more assurance, more opportunities with various tools, or more opportunities to network. The purpose of this study is to determine whether or not there is a difference between women's and men's perceptions of the professional internship in overcoming barriers in pursuit of an engineering degree and preparing them for the workforce, focusing particularly on the components of the internship and the skills developed during the internship. A comparison of the perceived needs of women as to those of men allows for the more focused development of internship opportunities that support women's persistence into an engineering field.

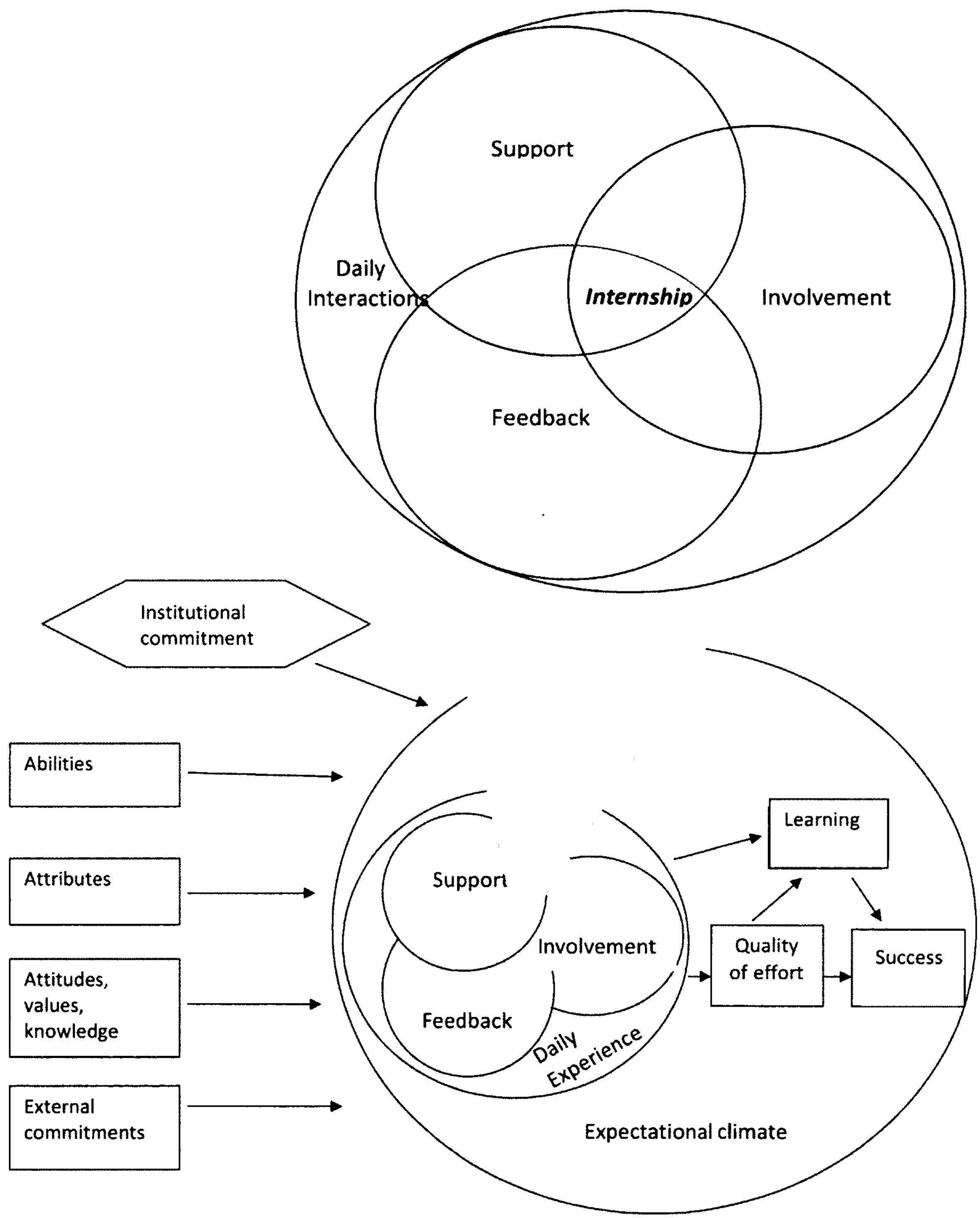

Figure 2.1: The benefit of the internship. Adapted from Tinto and Pusser (2006)

Chapter Three: Methodology

Using Tinto and Pusser's (2006) model as a conceptual framework, the purpose of this study was to determine whether or not there is a difference between women's and men's perceptions of the professional internship in overcoming barriers in pursuit of an engineering degree and preparing them for the workforce, focusing particularly on the components of the internship and the skills developed during the internship that contribute to persistence into the engineering profession. The elements and skills of an internship that are best for men in engineering may not provide adequate support to overcome the barriers that exist for women in these programs. Understanding more about the influence of the internship experience on men and women's decision making regarding engineering career choices can provide information to build better support systems for students, particularly women.

The null hypothesis H_{θ} for this study was:

There is no difference in how women and men perceive the professional internship.

This null hypothesis was researched through the following questions:

1. What elements of the internship are perceived by women as most important in preparing women for a profession in engineering as compared to those that are perceived by men as most important to preparing men?

This question tested the null hypothesis by asking what aspects of the internship are most important to women. Is it the mentor, networking opportunities, being on a research team, presentation or technical writing experiences, etc. If the null hypothesis was accepted, it could mean that there was no difference between what factors men and women respondents note benefitted them most in an internship experience. Within the conceptual framework, this question assessed support through social networking and advising through a mentor; feedback via technical report writing under the guidance of a mentor and poster and/or oral presentations; and involvement through engagement in a research team, the lecture series, tours, and a field trip (Tinto & Pusser, 2006).

2. What skills are developed in the internship that support women's persistence into an engineering profession as compared to the skills that support men's persistence?

This question tested the null hypothesis by asking what skills taught in the internship are most important to women's persistence into the field. Are communication skills less important than technical skills? What place do professional skills hold? Within the conceptual framework, this question assessed involvement specific to the skills taught in the internship that support learning and improve the quality of effort, which together increase the likelihood of successful transition into an engineering career (Tinto & Pusser, 2006).

Selection of a Quantitative Methodology

The philosophical assumptions of this study came out of post-positivism, recognizing that when dealing with people, there are no absolute truths, but that certain causes generally lead to specific outcomes (Creswell, 2003). Measurement and observation and the testing of theories lead to new knowledge and understanding (Creswell, 2003). In order to better understand the needs of the female engineering intern and identify trends among women in engineering programs, it is important to ask specific questions, analyze the resulting data, and draw relevant conclusions based on the information (Creswell, 2003). Future studies may apply alternative approaches to add to existing knowledge of women in engineering internships, but as an initial study of the topic, it is important to determine whether or not significant differences exist between men and women in an engineering internship. Finding answers to the research questions can be done by looking at performance data, attitude data, and/or self-observation data (Creswell, 2003). Quantitative methods provide the best way to collect data on multiple unobservable phenomena simultaneously, in this case, the experiences of interns during and after their internship (Gall, Gall, & Borg, 2007).

Research Design

Cross-sectional surveys are the most common survey design used in educational research to examine people's attitudes, beliefs, opinions, and practices (Creswell, 2012). The purpose of the Langley Aerospace Research Student Scholars (LARSS) study was actually twofold: to assess the perceptions of the participants about their individual experience before, during, and after the internship (attitudes, beliefs, opinions, and practices), and to evaluate the LARSS program as a whole. Evaluative studies are dependent in part on the needs of the stakeholders (Kiess & Green, 2010). Thus, based on the needs of key stakeholders, human resource questions were distributed throughout the LARSS survey to ensure that the program is effective not only in its outcomes, but also in its organization within NASA.

For the purposes of the current study, the focus was on the student experience, specifically during and after the LARSS internship. One task was to compare male and female former interns' experiences during the LARSS internship and determine which aspects of the internship were most important to each population. Another task was to examine attitudes and beliefs of women in the engineering field regarding their preparation during the internship. Which skills developed during the internship were most valuable in the field? Both of these tasks were best served through a cross-sectional design (Creswell, 2012).

Study Location

NASA 's Langley Research Center (LaRC) is located in Hampton Virginia and is the oldest of all the NASA centers in the United States (Allen, 2011). Developed in 1917, LaRC has been developing flight technology for aircraft (and later, spacecraft) for 95 years (Allen, 2011). As a research center, LaRC employs over 1,160 engineers, 213 women and 947 men (Lisa Etheridge, personal communication, February 5, 2013). NASA LaRC offers multiple internship opportunities to students at all levels of education from high school to graduate school. The participants for the current study come from the NASA LARSS program. The LARSS student internship program brings engineering, science, mathematics, and non-STEM students to NASA Langley, in Hampton, Virginia from all across the country to participate in 10 or 15 week internships under the guidance of engineers in a variety of engineering fields, including aeronautical, mechanical, electrical, computer, and bio-medical engineering. This program has reached hundreds of engineering students over the past 26 years and was named as one of the top internships in the country in 2011 (Vault, 2012). As a workforce development program supporting a large number of engineering students, the LARSS summer internship program provides a unique and optimal site for the current study.

Study Population

LARSS is a highly competitive paid internship program. Internship opportunities are available to students in high school, community college, undergraduate, and graduate programs. The majority of LARSS interns are in STEM fields, although there are also interns in education, human resources, and business. To participate, the individual must be a full time student at an accredited U.S. college or university with a cumulative GPA of 3.0 or higher on a 4.0 scale. All interns must be U.S. citizens. The goal of LARSS is to prepare students for the STEM workforce by providing practical, hands-on experiences on multi-disciplinary teams in the field. LARSS interns in STEM fields are mentored by NASA engineers and scientists as they work on current NASA research. Students have opportunities to work on patents, publications, and professional presentations as a result of their work at NASA LaRC. LARSS offers three sessions throughout the year, a 15-week fall internship, a 15-week spring internship, and a 10-week summer internship. The summer internship program has run continuously for 26 years and is the subject of a LARSS research project initiated by the Office of Education at NASA Langley in the spring of 2012. The LARSS study consisted of a cross-sectional survey of former STEM summer interns between 1986 and 2011. The current study is part of this larger research project.

Study Participants

The larger LARSS study sought out former LARSS participants over a 25 year period, from 1986 to 2011 to determine their academic and career trajectories since leaving LARSS, the impact of LARSS on their academic and career decisions, and the relevance of the skills and opportunities in LARSS on participants' workforce success.

Over the 25 years 2,574 student internships were held in the LARSS summer internship program. Those who did not have STEM majors at the time of their internship were not included in the NASA study, reducing the population to 2,174. In addition, 417 students completed more than one rotation in the LARSS internship program, and were only counted for their last experience, further reducing the total number to 1,757. Of this population, only those who participated between the years 2001 and 2011 as engineering students will be included in the current study.

This study focused on participants in the LARSS summer student internship program who were enrolled as engineering majors in a high school, college, or university between the years 2001 and 2011. The 2001-2011 group was selected because this cluster has most recently made the transition from school to career and is most likely to recall vividly the impact of the LARSS program on their decisions. Of the 1,213 students who participated in the LARSS program between 2001 and 2011, 685 were engineering majors. Details on the selection of participants can be found below in the Data Collection section, but of those for whom an email or social media address was identified, 419 were determined to be eligible for the current study based on having an engineering major at the time of their internship. These 419 made up the total census population for the current study, with 121 women and 298 men. The low population of women limited the statistics that could be applied in the current study (Keiss & Green, 2010).

Instrumentation

The data for this study was a part the NASA LARSS Longitudinal Study conducted by the Office of Education at NASA Langley in Hampton, Virginia in 2012 through the use of an online survey. Below is an overview of the survey's development.

Survey development

In the spring of 2012, NASA Langley put together a team of individuals to begin development of a survey instrument to use for the LARSS Longitudinal Study. The team consisted of a professor of psychology with extensive experience in survey design and development, a doctoral student in educational policy, planning and leadership, the University Affairs Officer of NASA Langley's Office of Education, and three high school interns. The team began by establishing the key goals of the evaluation, namely to 1. Determine the impact of the LARSS internship on the students' academic and career choices following their internship, 2. Identify what influences drew students to an interest in STEM, both people and experiences. 3. Determine where students went following their internship. Following the establishment of these goals, the team met with relevant stakeholders, convening meetings with the NASA administration, mentors of former interns, individuals working directly with the program providing funding and support, new NASA hires, and former and current students. These groups were specifically chosen for their involvement in the internship program and the likelihood that they would have a political, human resource, or financial interest in the outcomes of this study. Recommendations included the addition of questions about how students learned of the internship, if they had become mentors themselves, and what parts of the country they had been employed.

With the stakeholder input as well as examples of studies of a similar nature, (Cornell Alumni/Alumnae Survey, 2009; Ruiz et al., 1999; Wright et al., 2007) the team developed a series of questions that fit into five categories: Your Life Now, Jobs and Careers, Education since LARSS Program, Your LARSS Internship, and Interest in

STEM, followed by a Demographics section. All together, there were 57 questions in this version of the survey. Ultimately, the survey questions reflected NASA's strategic workforce mission of advancing education and persistence in STEM fields as well as a series of human resource questions desired by the administration. The next phase was consulting with two experts, one an evaluation expert and the other a NASA administrator to determine which questions did and did not fit the goals of the survey. The next version of the study contained 43 questions and combined the educational and professional experience sections together and made the Your Life Now section optional. Work began with the rest of the expert review panel (mentioned above) and this survey went through two more iterations until the final draft of the survey covered three key areas of questions for former interns: 1) education and professional experience 2) the LARSS internship experience; and 3) interest in STEM. A series of demographic questions and the optional 'Your Life Now' section was also included (Appendix A).

Dillman (2000) suggested the use of varying structures for questions in a self-administered survey. Open-ended questions; closed-ended, ordered response questions; and closed-ended, unordered questions are all appropriate for the different purposes in a self-administered survey, as long as the questions are carefully constructed (Dillman, 2000). Carefully constructed questions meet several criteria as spelled out by Dillman (2000), and include using simple words, keep the question as short as possible, use complete sentences, be precise, avoid excessive specificity that will challenge the respondent's recall, ensure that Likert scales are balanced between the positive and negative sides, place undecided options at the end of the options list, avoid bias, and ensure that response categories are mutually exclusive.

In the LARSS survey, the first section of 12 questions, Education and Professional Experience, focused on queries about the interns' education and careers since leaving LARSS. There were five yes or no questions, three check-the-box questions, three open-ended questions with multiple parts, including drop-down menus and fill in the blank questions. The last question was actually a list of STEM occupations adapted from the U.S. Department of Commerce, made available for those unsure if their field is considered a STEM field. The open-ended questions with multiple parts consisted of three to five components, all related to academic or work history. For example, the question about career history had five sections, including the question "In what sector did you work?", "What kind of work did you do in your principle occupation?", "Was the position full time or part time?", and "Geographically, what region was this position located in?" each had drop down menus from which to choose an answer. Although these questions were side by side, they funneled from one to another presenting a more complete picture of the participant's workforce experience (Dillman, 2000). Only the question "Approximately how long were you in this position?" required the respondent to fill in the year. All of these question formats conform to Dillman's (2000) recommendations for open-ended questions, making specific queries, building in probes, and getting at useable information. Within this section, the question about past careers will be included in the descriptive statistics of how many students went into an engineering field following their LARSS internship.

The second section, Your LARSS Internship, was devoted to questions about the LARSS internship and its impact on the intern's career. This section included 11 questions, eight closed-ended ordered response questions on a Likert scale. Two close-ended questions were also included, each followed by a list of possible answers. One of the close-ended questions asking how the participant learned about the internship program will be included in the descriptive statistics, specifically looking at those who learned about the internship from a professor or advisor. Seven of the Likert scale questions from this section will be analyzed for the current study.

The third section, Interest in STEM, was made up of six questions with two open-ended questions, one unordered closed-ended question, and two Likert scales. One of the open-ended questions was an open comment space where participants could write about anything they thought would enhance the research team's understanding of their experience before, during or after their internship. The last question in this section asked about demographics and the intern's last LARSS internship through drop down menus and short open-ended questions, including gender, race/ethnicity, classification at time of internship, year of internship, and LARSS mentor, to ensure that existing data was accurate. Only the demographics questions and open comment responses in this section were included in the current study.

The fourth and fifth sections were optional and contained three and two questions, respectively. The Follow-up Information section included a question on the participants' willingness to participate in a follow-up interview and interest in a copy of the results. The optional Your Life Now section asked two closed-ended unordered questions.

Several questions in the survey served specific stakeholder's interests, limiting the cohesiveness of the survey as a whole. Human resource purposes included questions about primary employment which sought to determine the sector of the job (government, private, or public) and the geographic region where the job is located as well as how interns learned of the LARSS internship. Because evaluation research is dependent on multiple stakeholders for multiple purposes, specific criteria are set to standardize the evaluation process (Gall, Gall, & Borg, 2007). Stufflebeam's (2004) Evaluation Design Checklist was utilized as a guideline for the LARSS study to ensure that the study was sound in its design (Gall, Gall, & Borg, 2007; Stufflebeam, 2004). Specific to the survey, questionnaire researchers, including those completing the LARSS study, are usually more interested in the collective response, not the individual response; and group level data analysis requires a lower level of item reliability than individual analysis (Gall, Gall, & Borg, 2007).

Validity

Validity is important in all research; however, the standards for questionnaires are often looser in practice than those for tests (Gall, Gall, & Borg, 2007). This difference is due to the nature of the questions in surveys, which are often highly structured, asking for information that is likely to be accurate, for example, the participant's year of graduation, major, employment, etc. (Gall, Gall, & Borg, 2007). Content-related evidence of validity is determined through the content and format of an instrument and is often determined by expert judges (Fraenkel & Wallen, 2006).

"The goal of writing a survey question…is to develop a query that every potential respondent will interpret in the same way, be able to respond to accurately, and be willing to answer" (Dillman, 2000, p. 32). To this end, the survey was assessed by an expert panel consisting of two professional evaluators, two professors, an evaluation consulting firm, an engineer, and a technical writer/editor. Their role was to ensure content validity by determining if the instrument had an adequate number of questions across each domain of interest and if the format was clear, questions were presented appropriately, and directions were well articulated (Fraenkel & Wallen, 2006). The expert panel was given the goals and objectives of the study and the purpose of each section and asked to mark all questions that did not fit the intended purpose, could have multiple meanings, or were not formatted appropriately (Fraenkel & Wallen, 2006).

Many changes were made from the original survey based on the advice of the expert panel (see Appendix B). For example, the original survey focused more on college experience, particularly for those currently in college. However, because the survey was being distributed to interns who had graduated from college as much as 25 years ago, these questions were cut from the survey. The original survey had 54 questions, which were reduced to 34 under the guidance of the expert panel. A final example is that the original scale was a seven point scale, which was deemed too detailed for some who have been out of the internship for 10 years or more. The scale was thus reduced to a five point scale. Once all the changes had been made, the expert panel once again went through the survey, with the same task as the first time. Only a few changes were recommended in the second reading, and by the third reading, there were no changes required and the survey was proclaimed ready. Content validity for the survey was determined to occur given the steps taken in survey construction.

Pilot study

Once the survey was finalized, it was uploaded into Qualtrics, an online survey platform, and a pilot study was conducted with 45 volunteers of multiple ages, positions, and levels of experience in science, technology, engineering, and mathematics. These volunteers were selected based on their experience with the LARSS program, either as students or as mentors, and their years of experience in a STEM field. A range of ages were included in the pilot study, from current LARSS students to senior mentors at LaRC to ensure that the pilot sample reflected the actual sample and to determine if any of the questions were too specific to any one age group. Meetings were held with each pilot participant following their completion of the survey to discuss the survey content and format. Based on feedback from these meetings, modifications to the survey were made. For example, one of the questions which had five parts was discovered to only show three parts on the iPad, requiring clarification in the directions. Another issue was raised by a first generation college student who had an older brother – should he define himself as first generation or not? Clarification was added to the directions for this question. To the question about whether or not LARSS helped the intern determine his or her career goals an option was added "I had clear career goals before I participated in LARSS" to account for those who had already decided their career path before arriving at LARSS. Once these changes were made, the survey was sent to the original expert panel to ensure content clarity and appropriate formatting of the altered questions (Fraenkel & Wallen, 2006). The expert panel reviewed and accepted the changes and the final version of the survey was set.

Online survey

The online survey was created in Qualtrics©, an internet survey program. Internet surveys have many advantages. The cost is lower than phone or mail surveys; there is the potential for a quick turnaround; as with mailed interviews, participants have time to think about their responses; and they are self-administered, allowing for more complex questions and the grouping of similar questions without the risk of redundancy (Fowler, 2009). Additionally, computer-based formats allow for skip-logic or contingency questioning, which adjust the next question to be asked based on the previous answer (Fowler, 2009).

Qualtrics survey software provides excellent phone support and a Qualtrics University site where many questions are answered through videos and written explanations. These resources were used to develop panels of embedded data that included name, email, gender, race/ethnicity, year of participation, mentor, and directorate (similar to a department) for each former intern. Qualtrics University support was also used in determining the best way to organize questions that incorporate skip-logic. Questions in Qualtrics can be arranged in different blocks, allowing the developer to arrange the survey by subtests. Skip logic can be applied throughout the survey to ensure that participants are not asked irrelevant questions. For example, one of the questions in this survey asks if the participant is currently in a STEM career. There are three answer options, yes, no, and not sure. Each response prompts the participant to a different screen. For yes, she goes to a question about what type of STEM career she is in, for no she is directed to a question about why she left STEM, and for not sure, she is given a listing from the Department of Commerce of STEM careers before being directed back to the original question, where she can answer yes or no. Depending on the yes or no answer, the participant is taken to a separate series of questions.

Institutional Review Board

The completed survey and study design were submitted to the College of William and Mary's Institutional Review Board for approval. The study was exempted from formal review as it complied with appropriate ethical standards (Appendix C).

Data Collection

Data collection for the current survey is directly tied to the original NASA LARSS survey. The original survey spanned 25 years, however, the current survey only spans the most recent 10 years. The process of data collection for the larger NASA LARSS study began with locating and contacting participants across the 25 year span, obtaining cooperation, and administering the survey. To enlist cooperation from the participants the survey was sent through an identifiable sponsor, namely NASA; the instrument was well-designed based on feedback from engineers, scientists, mathematicians, and technicians who participated in the pilot, as well as the professional evaluators; and repeated contacts were made (Fowler, 2009). In spite of the efforts of the research team, multiple complications were experienced in locating the interns involved over the 25 year period, and distributing the survey, resulting in a smaller pool of participants. These issues involved three problematic areas: contacting participants, obtaining cooperation, and administering the survey.

Contacting participants.

One of the challenges with an internet survey is that it is limited to those for whom a viable email address exists (Fowler, 2009). As such, the first task for the NASA LARSS study team was to locate email addresses for the former interns over the 25 year span from 1986-2011. Using social media, Google searches, mentor correspondence, and university alumni offices, three LARSS 2012 students were able to obtain internet based information for nearly 1,300 of the 1,757 interns involved over this timeframe. All of those for whom an email address, LinkedIn account, or Facebook account were found were contacted accordingly in late August or early September and invited to participate in survey of the LARSS program. One said he did not wish to participate, nine responded that they had not actually participated in the program, and the remaining contacts either wrote back agreeing to participate or did not respond. Of the nine who did not participate, reasons included that they had been accepted for the internship, but had pulled out at the last minute, that they had applied, but had not been accepted, or, for one, had been a mentor in the program, not an intern. These nine errors were determined to be clerical errors at the time of the students' application. The end result was a census sample of 1,050, 920 email addresses and 130 LinkedIn and Facebook connections.

Obtaining cooperation

In the first week of November, after a delay of approximately three weeks for administrative reasons, an email message with the survey link (Appendix D) was sent to all potential participants (1,050). The survey was emailed to all former interns for whom an email address existed; a total of 920. Over the following week, the remaining 130 surveys were sent through LinkedIn and Facebook one at a time. The survey link took the participant to the cover page of the survey, which provided an opt-out and asked for consent to participate, which was given by clicking 'yes.' If participants chose 'no' at this point, they were redirected to a screen thanking them for their time and exiting them from the survey. None of the emails sent bounced back at this stage. However, it was discovered that some students who had multiple email accounts did not check the account that the survey was delivered to and missed the opportunity to participate. This was true for at least two former interns.

Administering survey

As noted, the survey was administered through Qualtrics, a secure web-based survey software system. An individual, secure link was connected to each member of the sample and sent to the individuals through email or Facebook. Alternative means of contact were sought for the 55 in the LinkedIn population; primarily through alumni offices and continued Google searches. Several of the contacts through LinkedIn were eventually lost due to lack of access to other contact information, leaving the total number of surveys sent at 995.

As noted, participants were advised in the Qualtrics email that they could stop or withdraw at any time. No answers were required. They were also told that the survey was expected to take approximately 20-25 minutes, based on the pilot study. Once in the survey, a status bar appeared on the bottom of each screen and beneath that, a statement from the College IRB review board stating that the project complied with ethical standards. The survey software allows for the opening of one question at a time, and this option was selected. At the end of the survey, participants had the option to provide additional information, request a copy of the study results, and volunteer to participate in a follow up interview.

Methods of Analysis

Before any statistics were run for the research question itself, a test of survey bias was run to ensure that the sample reflects the larger population (Creswell, 2012). Response bias was tested on non-responders using the variables of gender, classification, and major to determine if there are certain characteristics that differ between responders and non-responders. One hundred sixty one persons from each group were randomly selected for this analysis. This test helped to determine what types of students were more likely to respond among men and women, undergraduate and graduate, and of the various engineering majors.

The method of analysis was different for each part of the research question. However, for both sub-questions the type of statistic was limited by the low sample of women that was obtained. Descriptive statistics were used to define the size of the male and female samples of engineers and gender pairings of mentors and interns. Multivariate t-tests were run for sub-question one (What elements of the internship are perceived by women as most important in preparing women for a profession in engineering as compared to those that are perceived as most important to men?). A 2x2 Repeated Measures Multivariate analysis was run for sub-question two (What skills are developed in the internship that support women's persistence into an engineering profession as compared to men?). The results of the multivariate t-tests were compared using univariate statistics (George & Mallery, 2012).

The null hypothesis (H_{θ}) stated that there is no difference in how women and men perceive the professional internship; this hypothesis was researched through two sub-questions comparing women to men using specific questions from the LARSS survey (Appendix E). Descriptive statistics present basic information about the sample (Kiess & Green, 2010). They were used to define how many women and men had engineering majors at the time of their LARSS internship and how many went into an engineering career. These statistics were essential for accurately defining the samples that sub-questions one and two would apply to. Specifically, sub-question one was for all women and men who had engineering majors, however, sub-question two was specific to those with engineering majors who went into an engineering career. Descriptive statistics also provided information specific to how many interns were paired with a mentor of the same sex and how many students learned of the internship through a professor or advisor. These descriptive data presented an objective overview of the collected information (Keiss & Green, 2010) and provided context for the overall internship experience.

Method for sub-question 1

The first sub-question asked what elements of the internship are perceived by women as most important in preparing women for a profession in engineering as compared to those that are perceived as most important to men to preparing men. The independent variable in this question was gender. There were nine dependent variables: mentoring, research project, networking, lecture series, career enhancement seminars, technical report writing, presentations, on center tours, and field trips (Appendix F). However, because the field trip was only open to a limited number of students each year, this variable was removed. To test this question, a multivariate t-test was run. An independent samples t-test is appropriate when comparing two groups on one or more dependent variables when the population mean and standard deviation are unknown (Kiess & Green, 2010). To test more than one dependent variable without great risk of a Type 1 error requires a multivariate t-test, an expansion of the independent t-test (Stevens, 2002). The multivariate test accounts for small differences of individual variables which collectively may produce a significant difference (Stevens, 2002). To compensate for alpha slippage, the alpha was set at .10, an acceptable setting for an exploratory study (Gall, Gall, & Borg, 2007). Because no research exists on the difference between the perceptions of men and women on the impact of the internship on persistence into an engineering career, a two-tailed test of significance was run (Creswell, 2012).

Method for sub-question 2

The second sub-question asks what skills are developed in the internship that support women's persistence into an engineering profession as compared to the skills that support men's persistence into an engineering profession. The independent variable in this question is gender. There are 20 dependent variables: thinking critically, exercising judgment, making sound decisions, solving problems, solving problems, creating and/or innovating, time management skills, appreciation for diversity, demonstrating professional behavior, working independently, leadership skills, continuous learning, communicating in writing, communicating orally/verbally, collaborating/working with others, adapting to change, working as part of a research team, thinking analytically, computational skills, computer skills, and technical skills (Appendix F).

Testing this question was done with a 2x2 Repeated Measures Multivariate Analysis. The skills taught during the internship experience were compared to the skills required in an engineering job. Each skill was assessed for men and women. The number of engineering majors was determined from the results of the study, specifically the question asking for academic major during the internship, and was not known for all students before the survey was completed.

Summary

This study examined the perceived impact of a LARSS internship on women's persistence into an engineering career. Quantitative methods are best for this study based on the focus on identifying trends among women engineering students (Creswell, 2012).

As part of a larger study, participants completed an online survey about their experiences before, during, and after their participation in a LARSS internship at NASA Langley. The data from the 2001-2011 population was used for the current study. This data set was further reduced to look specifically at engineering students over that time period. Using specific survey data from the NASA survey, the preceding research questions were explored and analyzed through descriptive statistics, multivariate t-tests, and repeated measures multivariate analysis.

Chapter 4: Results

The purpose of this study was to determine whether or not there is a difference between women's and men's perceptions of the professional internship in overcoming barriers in pursuit of an engineering degree and preparing them for the workforce, focusing particularly on the components of the internship and the skills developed during the internship that contribute to persistence into the engineering profession. No research was found to suggest whether or not the elements and skills of an internship that are best for men in engineering academic programs provide adequate support to overcome the barriers that exist for women in these programs. Understanding more about the influence of the internship experience on men and women's decision making regarding engineering career choices can provide information to build better support systems for students, particularly women.

The null hypothesis H_{θ} for this study was: There is no difference in how women and men perceive the benefits of the professional internship for members of their own gender group. This null hypothesis was analyzed through two questions: What elements of the internship are perceived by women as most important in preparing women for a profession in engineering as compared to those that are perceived by men as most important to preparing men? And what skills are developed in the internship that support women's persistence into an engineering profession as compared to the skills that support men's persistence? Chapter four presents a discussion of the sample, followed by the results of the analyses run through SPSS 20 to assess the elements of the LARSS internship and the skills developed in the LARSS internship.

Sample

The census population for this study was made up of 419 engineering majors who interned in the LARSS program between 2001 and 2011; 121 women and 298 men. According to Dillman (2000), for a population of approximately 400, a sample of 153 is needed to ensure no more than a ±5 % sampling error. With a total of 166 respondents to the survey, this criterion was met. The resulting respondents included 42 women, 124 men, and one who did not specify gender. This sample represents 34.7% of the women in the population and 41.6% of the men. The total sample is 39.6% of the population. For the second research question, the sample is limited to only those former interns who are currently working in an engineering field. This criterion reduced the sample of women from 42 to 27 (64.3% of the women in the total sample) and of men from 124 to 88 (71.0% of the men in the total sample). In her study comparing the relationship between highest degree and current job for men and women, Hunt (2010) found that about 60% of both men and women with engineering degrees were working in jobs closely related to engineering. Although Hunt combines Computer Science with engineering for this study, a comparison of her results with those of the current study suggests that LARSS interns, both women and men, persist into the field at a higher rate than those from the National Surveys of College Graduates, which has a sample size of nearly 200,000.

Upon completion of data entry, four participants were removed who had not answered any of the questions for this study. Two were men and two were women. The participant whose gender was not disclosed was removed as well, as all the analyses were dependent upon gender. Finally, six of the male respondents for question two only completed half of the questions, and based on George and Mallery's (2012) guidelines of only replacing missing values for up to 15% of any one respondent, these six participants were removed from the analysis of the second question. As a result of these changes, the final number of respondents for the first question was 162 (122 men, 40 women) and for the second question, 109 (82 men, 27 women).

Beyond the concerns listed above, some questions throughout the survey were not answered by various participants. The decision to replace for missing values was made to ensure that legitimate data was not lost (George & Mallery, 2012). Percentages of unanswered questions varied between 0% and 9.8% with two exceptions. Thirteen and a half percent of the participants did not rate their experience with the career enhancement seminars and 44.8% did not participate in the field trip to another center. George and Mallery (2012) suggest that it is acceptable to replace up to 15% of the data for a variable without jeopardizing the outcome of the analysis. With the exception of the field trip question, missing values for all variables were less than 15% and were replaced using the SPSS option of replacing missing values with the "mean of nearby points" after splitting the file based on gender (George & Mallery, 2012). The file was split to ensure that men's substituted scores reflected the means of the men and that the women's replaced scores were based on the women in the sample. Because only half of the participants had participated in the field trip, the field trip variable was removed from the analysis.

Background information about the respondents included how they learned of the internship, how many females were with female mentors, and the academic classifications of the students. Of the total sample (n=162), 59 cited a professor and 25 cited their school career planning office as a source of information about the internship, accounting for 51.85% of all respondents. Thus, the school is an important source of information for internship opportunities. One hundred thirty two of the mentors were men (81.5%), 20 of them were women (12.3%), and 10 were unknown (6.2%). However, nine of the female interns (22.5%) and 11 of the male interns (7.75%) were matched with female mentors. Finally, respondents' academic classifications were spread across high school through graduate school with the majority holding graduate student status (See Table 4.1).

Table 4.1: *Academic Classification of Participants*

Classification	Number of Respondents
High School	1 (0.62%)
Freshmen	3 (1.85%)
Sophomore	16 (9.88%)
Junior	44 (27.16%)
Senior	38 (23.46%)
Graduate Student	49 (30.25%)
Unknown	11 (6.79%)
Total	162 (100%)

Response Bias

Response bias was measured for gender, classification, and major using chi square analysis. Alpha was set at .05 to determine if bias was present. Preliminary data was gathered on all of the members of the study population based on original applications to the LARSS internship program, including gender, ethnicity, classification in school, and academic major. Due to low sample sizes for ethnicity, this category was not included in the chi square analysis. For the analysis of the remaining variables, respondents were compared to non-respondents using a random sample of 161 responders and 161 non-responders.

Response bias was analyzed for gender, comparing respondents to non-respondents. Results were not significant for gender (See Table 4.2). There were no significant differences between women and men who completed the survey and those who did not.

Table 4.2: *Chi Square Gender*Response*

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.383[a]	1	.123		
Continuity Correction[b]	1.996	1	.158		
Likelihood Ratio	2.393	1	.122		
Fisher's Exact Test				.150	.079
Linear-by-Linear Association	2.376	1	.123		
N of Valid Cases	317				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 37.89.					
b. Computed only for a 2x2 table					

Response bias was analyzed for academic classification and response. Response bias was not found to be significant (See Table 4.3). There were no significant differences between respondents' academic classification and non-respondents'.

Table 4.3: *Chi Square Classification * Response*

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.914[a]	5	.426
Likelihood Ratio	4.980	5	.418
Linear-by-Linear Association	3.035	1	.081
N of Valid Cases	315		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.47.

Response bias was analyzed for academic major and response. Results were not found to be significant (See Table 4.4). There were no statistically significant differences between responders' academic majors and non-responders' academic majors.

Table 4.4: *Chi Square for Major * Response*

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.146[a]	10	.518
Likelihood Ratio	9.698	10	.467
Linear-by-Linear Association	.444	1	.505
N of Valid Cases	322		

Response bias was analyzed based on demographic information on gender, academic classification, and academic major. Survey participants did not differ from non-participants on any of the three variables.

Elements of the Internship

Internships provide a valuable authentic learning experience for students, but little is known regarding how men and women might perceive their involvement in this activity and if there are differences in this perception. The LARSS survey results help answer this question. A multivariate t-test was conducted comparing men and women's perceptions of the importance of eight elements of the internship: mentoring, participation in a research project, networking opportunities, lecture series, career enhancement seminars, technical writing, presentations, and on-center tours. Alpha was set at .10 for this question, based on the exploratory nature of this study. The number of participants responding to this question was 162, 40 women and 122 men.

Descriptive statistics show that most of the variables were within the expected range of ±1 or ±2 for skew and kurtosis (George & Mallery, 2012). The exception for men was mentoring (2.625) and for women participation in a research project (3.011) and networking (2.471). All three were leptokurtic. Leptokurtic distributions are narrower than a normal distribution, with more of the values around the mean and thicker tails (George & Mallery, 2012). A kurtosis value above 2 can be considered a deviation from normality, which can limit the types of statistics that can be run; namely removing all statistics that are dependent on normality. However, like the independent samples t-test, the multivariate t-test is robust enough to compensate for violations of normality (Boneau, 1960; Grimm & Yarnold, 2009; Posten, 1978). Although the t-test is most robust with equal sample sizes, Boneau (1960) found that with equal variances, there is little impact of unequal sample sizes on the outcomes in an independent samples t-test and Grimm and Yarnold (2009) report the same for multivariate statistics. Thus, the finding of leptokurtic distribution does not have an effect on the statistics chosen for this study.

The multivariate t-test (See Table 4.5) revealed a significant multivariate main effect for gender, Hotelling's Trace = .126, F (8,153) = 2.413, p = .018, partial η^2 = .112. This means that there is a difference between women and men's perceptions on the elements of the internship.

Table 4.5: *Multivariate Tests for Question 1*

Effect		Value	F	Hypoth-esis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Inter-cept	Pillai's Trace	.973	684.279^b	8.000	153.000	.000*	.973	5474.231	1.000
	Wilks' Lambda	.027	684.279^b	8.000	153.000	.000*	.973	5474.231	1.000
	Hotelling's Trace	35.779	684.279^b	8.000	153.000	.000*	.973	5474.231	1.000
	Roy's Largest Root	35.779	684.279^b	8.000	153.000	.000*	.973	5474.231	1.000
Gender	Pillai's Trace	.112	2.413^b	8.000	153.000	.018*	.112	19.302	.886
	Wilks' Lambda	.888	2.413^b	8.000	153.000	.018*	.112	19.302	.886
	Hotelling's Trace	.126	2.413^b	8.000	153.000	.018*	.112	19.302	.886
	Roy's Largest Root	.126	2.413^b	8.000	153.000	.018*	.112	19.302	.886

a. Design: Intercept + gender

b. Exact statistic

c. Computed using alpha = .05

Looking at the individual elements of the internship, between subjects effects (See Table 4.6) show significance at the .10 level for mentoring, $F\,(1) = 3.857$, $p = .051$, partial $\eta^2 = .024$, and for the research project, $F\,(1) = 6.844$, $p = .010$, partial $\eta^2 = .041$. Looking at descriptive statistics, men rated mentoring (M = 4.325, SD = .844) significantly higher than women rated mentoring (M = 3.993, SD = 1.150). Mentors in the LARSS internship were predominantly men. Only 11 men and nine women had female mentors. Men also rated participation in a research project (M = 4.572, SD = .641) significantly higher than women rated such participation (M = 4.225, SD = .947), suggesting a male preference for hands-on, active learning activities. No other variables were found to be significant. Based on the results of this analysis, one can reject the null hypothesis, as there is a difference in the way women and men perceive the value of the internship. Men score mentoring and participation in a research project significantly higher than women.

Table 4.6: *Tests of Between Subjects Effects for Question 1*

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Para-meter	bserved Power
Corrected Model	mentoring	3.322[a]	1	3.322	3.857	.051*	.024	3.857	.497
	researchproject	3.621[b]	1	3.621	6.844	.010*	.041	6.844	.739
	networking	.569[c]	1	.569	.480	.489	.003	.480	.106
	lectureseries	.315[d]	1	.315	.270	.604	.002	.270	.081
	careerenhance	.268[e]	1	.268	.234	.629	.001	.234	.077
	technicalwriting	.697[f]	1	.697	.648	.422	.004	.648	.126
	presentation	.098[g]	1	.098	.073	.788	.000	.073	.058
	oncentertour	2.273[h]	1	2.273	2.277	.133	.014	2.277	.323
Intercept	mentoring	2085.002	1	2085.002	2420.953	.000	.938	2420.953	1.000
	researchproject	2331.023	1	2331.023	4405.432	.000	.965	4405.432	1.000
	networking	1868.174	1	1868.174	1577.661	.000	.908	1577.661	1.000
	lectureseries	1225.102	1	1225.102	1050.781	.000	.868	1050.781	1.000
	careerenhance	1212.459	1	1212.459	1060.379	.000	.869	1060.379	1.000
	technicalwriting	1735.196	1	1735.196	1612.470	.000	.910	1612.470	1.000
	presentation	1431.283	1	1431.283	1062.520	.000	.869	1062.520	1.000
	oncentertour	1578.043	1	1578.043	1580.939	.000	.908	1580.939	1.000
Gender	mentoring	3.322	1	3.322	3.857	.051*	.024	3.857	.497
	researchproject	3.621	1	3.621	6.844	.010*	.041	6.844	.739
	networking	.569	1	.569	.480	.489	.003	.480	.106
	lectureseries	.315	1	.315	.270	.604	.002	.270	.081
	careerenhance	.268	1	.268	.234	.629	.001	.234	.077
	technicalwriting	.697	1	.697	.648	.422	.004	.648	.126
	presentation	.098	1	.098	.073	.788	.000	.073	.058
	oncentertour	2.273	1	2.273	2.277	.133	.014	2.277	.323

Anecdotally, it is interesting to note the way variables group together for men and women. The least important three elements were the same for men and women, namely the lecture series, the career-enhancement seminars, and the presentations. A notable difference is in the higher means, with men giving higher means to the more technical elements of the internship (research project, mentoring, and technical writing) and women assigning higher means to technical and social elements more evenly (research project, networking, mentoring; See Table 4.7). A larger sample of women would provide additional data to determine if this result is significant. This topic is an area in need of further study.

Table 4.7: *Grouping of technical and non-technical elements of the internship**

Women	Men
Research project (4.23)	Research project (4.57)
Networking (4.01)	Mentoring (4.33)
Mentoring (3.99)	Technical writing (3.871)
On center tour (3.76)	Networking (3.869)
Technical writing (3.72)	On center tour (3.48)
Poster/Presentation (3.48)	Poster/Presentation (3.42)
Lecture series (3.14)	Lecture series (3.24)
Career enhancement series (3.13)	Career enhancement series (3.22)

*Technical elements presented shaded.

Skills Developed in the Internship

The second research question asked what skills are developed in the internship that support women's persistence into the engineering field as compared to those that support men's persistence. The question was analyzed by looking at the difference between how important each skill is to male and female respondents in their engineering jobs (import) compared to how effective the LARSS internship was in developing each skill for males and females (effect). Two (gender) x 2 (importeffect) Repeated Measures Multivariate statistics were used to test this question. Due to the exploratory nature of this study, the alpha was set at .10.

The sample for the second question consisted only of those who were working in an engineering field at the time of the study. Of the total 162 in the sample, 115 were working in engineering, which is 71% of the original sample. Closer examination shows that 64.3% (n=27) of the women and 71.0% (n=88) of the men who participated in this survey are working in an engineering field today. According to Corbett & Hill (2012) of the American Association of University Women, 39% of women engineering graduates actually enter the engineering workforce as compared to 57% of male engineering graduates. The percentage of LARSS interns who enter the workforce is much higher than this, suggesting that there is something happening in the LARSS internship that is supporting persistence into the field, however what exactly that is remains unknown.

Looking at the sample for question two, six of the participants did not answer at least 85% of the questions (George and Mallery, 2012), requiring them to be removed before the analysis. All six were males, reducing the number of men in the sample to 82 (66.1%).

Results of the 2x2 Multivariate Repeated Measures Analysis revealed a statistically significant difference in the importance versus effectiveness scale, F (20,88) = 8.694, p = .000, Wilks' Lambda = .336, partial η = .664, but no statistically significant difference based on gender (See Table 4.7). Thus, there are significant differences between how important certain skills are to the engineering job and how effective the LARSS internship is in developing these skills, but there are no significant differences between women and men's perceptions of these two variables.

Table 4.8: *Multivariate Tests for Question 2*

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Para meter	Observed Power[c]
Between Subjects	Intercept	Wilks' Lambda	.015	285.110[b]	20.000	88.000	.000	.985	5702.207	1.000
	gender	Wilks' Lambda	.774	1.281[b]	20.000	88.000	.213	.226	25.626	.818
Within Subjects	Import Effect	Wilks' Lambda	.336	8.694[b]	20.000	88.000	.000	.664	173.886	1.000
	Import Effect * gender	Wilks' Lambda	.772	1.302[b]	20.000	88.000	.200	.228	26.041	.826

Follow up univariate statistics identify significance in 17 of the 20 variables using the Greenhouse-Geisser measure (See Table 4.8). In the category of critical thinking, four of the five skills were significant: thinking critically (F=73.289, p=.000), judgment (F=73.441, p=.000), decision making (F=78.693, p=.000), problem solving (F=42.675, p=.000). In the category of professional skills, four of the six skills were significant: time management (F=39.431, p=.000), professional behavior (F=5.004; p=.027), leadership (F=22.029, p=.000), and lifelong learning (F=13.580, p=.000). In the category of communication and collaboration, all five skills were significant: written communication (F=49.650, p=.000), oral communication (F=59.643, p=.000), adaptability (F=41.186, p=.000), collaboration (F=42.275, p=.000), and teamwork (F=3.666, p=.058). Finally, the four skills in the technical/STEM skill set were all significant: analytical skills (F=22.662, p=.000), computational skills (F=15.050, p=.000), computer skills (F=24.467, p=.000), and technical skills (F=46.558, p=.000). The three variables that were not found to be significant were creativity, diversity, and independence. For these three variables the importance of the skill for the job was not significantly different from the effectiveness of the internship to develop the skill. The importance of creativity on the job (Mean = 3.66; SD = 1.03) was statistically similar to the effectiveness of the internship to develop creativity (Mean = 3.34; SD = 1.12), suggesting that the internship was effective at preparing interns for the level of creativity they needed on the job. The importance of diversity on the job (Mean = 2.94; SD = 1.18) was statistically similar to the effectiveness of the internship to prepare interns for diversity in the field (Mean = 2.89; SD = 1.15). Finally, the importance of independence on the job (Mean = 3.92; SD = 1.00) was statistically similar to the effectiveness of the internship to prepare interns for independence in the field (Mean = 3.99; SD = .98). For all other variables, the means for the importance of the skill on the job were significantly higher than the means for effectiveness of the internship to prepare interns for the skills in the field. Effect sizes range from insignificant (teamwork $\eta = .033$) to small (analytical thinking $\eta = .205$) to medium (decision making $\eta = .424$; Grimm & Yarnold, 2009).

Although statistical significance was found between the importance of many of the skills and the effectiveness of the internship to develop those skills, there was no significance found for gender. The research question asked what skills are developed in the internship that support women's persistence into the engineering field as compared to those that support men's persistence and for this question no differences were found. As a result, one must accept the null hypothesis that there is no difference between women's and men's perceptions of the professional internship in overcoming barriers in pursuit of an engineering degree and preparing each gender for the workforce as relates to the skills developed during the internship.

The results of the 2x2 Repeated Measures Multivariate statistics should be interpreted with caution, however, as the small sample of women under-powers this vector. Future studies should seek to increase the number of women respondents who are working in an engineering field in order to more fully represent this population.

Table 4.9: *Multivariate Tests*[a]

Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Import Effect	thinkcrit	Greenhouse-Geisser	33.666	1.000	33.666	73.289	.000	.407	73.289	1.000
	judge	Greenhouse-Geisser	35.696	1.000	35.696	73.441	.000	.407	73.441	1.000
	decisions	Greenhouse-Geisser	39.875	1.000	39.875	78.693	.000	.424	78.693	1.000
	solve	Greenhouse-Geisser	20.440	1.000	20.440	42.675	.000	.285	42.675	1.000
	create	Greenhouse-Geisser	1.913	1.000	1.913	1.987	.162	.018	1.987	.287
	time	Greenhouse-Geisser	34.595	1.000	34.595	39.431	.000	.269	39.431	1.000
	diversity	Greenhouse-Geisser	.085	1.000	.085	.112	.738	.001	.112	.063
	professional	Greenhouse-Geisser	2.843	1.000	2.843	5.004	.027	.045	5.004	.601
	independence	Greenhouse-Geisser	.086	1.000	.086	.137	.712	.001	.137	.066
	leader	Greenhouse-Geisser	17.429	1.000	17.429	22.029	.000	.171	22.029	.996
	lifelong	Greenhouse-Geisser	8.821	1.000	8.821	13.580	.000	.113	13.580	.955
	writing	Greenhouse-Geisser	35.647	1.000	35.647	49.650	.000	.317	49.650	1.000

	oral	Greenhouse-Geisser	40.149	1.000	40.149	59.643	.000	.358	59.643	1.000
	adapt	Greenhouse-Geisser	36.752	1.000	36.752	41.186	.000	.278	41.186	1.000
	collaborate	Greenhouse-Geisser	36.294	1.000	36.294	42.275	.000	.283	42.275	1.000
Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power [a]
	team	Greenhouse-Geisser	4.229	1.000	4.229	3.666	.058	.033	3.666	.475
	analytical	Greenhouse-Geisser	11.350	1.000	11.350	27.662	.000	.205	27.662	.999
	computation	Greenhouse-Geisser	12.966	1.000	12.966	15.050	.000	.123	15.050	.970
	computer	Greenhouse-Geisser	18.791	1.000	18.791	24.467	.000	.186	24.467	.998
	technical	Greenhouse-Geisser	25.049	1.000	25.049	46.558	.000	.303	46.558	1.000
Import Effect * gender	thinkcrit	Greenhouse-Geisser	.371	1.000	.371	.807	.371	.007	.807	.145
	judge	Greenhouse-Geisser	.529	1.000	.529	1.088	.299	.010	1.088	.179
	decisions	Greenhouse-Geisser	.293	1.000	.293	.578	.449	.005	.578	.117
	solve	Greenhouse-Geisser	2.519	1.000	2.519	5.259	.024	.047	5.259	.623
	create	Greenhouse-Geisser	1.932	1.000	1.932	2.006	.160	.018	2.006	.289
	time	Greenhouse-Geisser	2.492	1.000	2.492	2.841	.095	.026	2.841	.386
	diversity	Greenhouse-Geisser	.007	1.000	.007	.009	.925	.000	.009	.051
	professional	Greenhouse-Geisser	.100	1.000	.100	.177	.675	.002	.177	.070

	independence	Greenhouse-Geisser	.032	1.000	.032	.051	.822	.000	.051	.056
	leader	Greenhouse-Geisser	.570	1.000	.570	.721	.398	.007	.721	.134
	lifelong	Greenhouse-Geisser	1.754	1.000	1.754	2.700	.103	.025	2.700	.370
Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
	writing	Greenhouse-Geisser	.110	1.000	.110	.153	.697	.001	.153	.067
	oral	Greenhouse-Geisser	.018	1.000	.018	.026	.871	.000	.026	.053
	adapt	Greenhouse-Geisser	.089	1.000	.089	.100	.753	.001	.100	.061
	collaborate	Greenhouse-Geisser	.648	1.000	.648	.755	.387	.007	.755	.138
	team	Greenhouse-Geisser	3.828	1.000	3.828	3.318	.071	.030	3.318	.439
	analytical	Greenhouse-Geisser	1.011	1.000	1.011	2.463	.119	.023	2.463	.343
	computation	Greenhouse-Geisser	.072	1.000	.072	.083	.773	.001	.083	.059
	computer	Greenhouse-Geisser	.066	1.000	.066	.085	.771	.001	.085	.060
	technical	Greenhouse-Geisser	.065	1.000	.065	.120	.730	.001	.120	.064
Error (Import Effect)	thinkcrit	Greenhouse-Geisser	49.152	107.000	.459					
	judge	Greenhouse-Geisser	52.007	107.000	.486					
	decisions	Greenhouse-Geisser	54.219	107.000	.507					
	solve	Greenhouse-Geisser	51.249	107.000	.479					

	create	Greenhouse-Geisser	103.028	107.000	.963					
	time	Greenhouse-Geisser	93.878	107.000	.877					
	diversity	Greenhouse-Geisser	80.711	107.000	.754					
Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
	professional	Greenhouse-Geisser	60.783	107.000	.568					
	independence	Greenhouse-Geisser	67.275	107.000	.629					
	leader	Greenhouse-Geisser	84.653	107.000	.791					
	lifelong	Greenhouse-Geisser	69.504	107.000	.650					
	writing	Greenhouse-Geisser	76.821	107.000	.718					
	oral	Greenhouse-Geisser	72.027	107.000	.673					
	adapt	Greenhouse-Geisser	95.481	107.000	.892					
	collaborate	Greenhouse-Geisser	91.861	107.000	.859					
	team	Greenhouse-Geisser	123.429	107.000	1.154					
	analytical	Greenhouse-Geisser	43.904	107.000	.410					
	computation	Greenhouse-Geisser	92.184	107.000	.862					
	computer	Greenhouse-Geisser	82.175	107.000	.768					
	technical	Greenhouse-Geisser	57.566	107.000	.538					

a. Computed using alpha = .05

Differences of Perception Regarding the Professional Internship

The null hypothesis asked if there is a difference between women's and men's perceptions of the professional internship in overcoming barriers in pursuit of an engineering degree and preparing them for the workforce, focused particularly on the components of the internship and the skills developed during the internship. To test this hypothesis two questions were analyzed using SPSS 20 statistical software. The first question asked what elements of the internship are perceived by women as most important in preparing women for a profession in engineering as compared to those that are perceived by men as most important for preparing men. Based on results of a Multivariate T-Test, men perceived mentoring and participation in the research experience as more important than women perceived them. The second question asked what skills are developed in the internship that support women's persistence into an engineering profession as compared to those that support men's persistence into an engineering profession. Multivariate statistics were run on this question comparing women and men's perceptions of what skills they need in their engineering position compared to their preparation in the LARSS internship. Results of the 2x2 Repeated Measures MANOVA suggested that there is no significant difference between men and women's perceptions of the importance of the skills in their engineering positions and the effectiveness of LARSS in preparing them in each of these skills. Based on just these findings, the null hypothesis is rejected. However, univariate statistics on the within-subjects effects present a statistically significant relationship between 17 of the 20 skills. These results suggest that for 17 of the 20 variables, female and male interns rated the importance of the skill in the field higher than their preparation in the skill during their LARSS internship.

There is a difference between the perceptions of men and women on the importance of the elements of the internship in preparing them for a career in engineering. For both mentoring and the research project, the means for men were significantly higher than for women. Based on this finding, the null hypothesis is rejected. There is no difference between men and women's perceptions of the importance of the 20 skills analyzed for their engineering jobs and the effectiveness of the internship to develop those skills. One interesting finding is in the significant differences between the skills that are important for the engineering job and the effectiveness of the internship to develop these skills. Once again, caution is advised in drawing broad inferences on these results based on the low number of women respondents, particularly for the second research question, for which there were fewer than 30 female respondents.

Chapter 5: Discussion

The purpose of this study was to determine whether or not there is a difference between women's and men's perceptions of the professional internship in overcoming barriers in pursuit of an engineering degree and preparing them for the workforce, focusing particularly on the components of the internship and the skills developed during the internship. No research was found to suggest whether or not the elements and skills of an internship that are best for men in engineering academic programs provide adequate support to overcome the barriers that exist for women in these programs. As such, this exploratory study sought to understand more about the influence the internship has on women's and men's decisions about pursuing an engineering career and begin a conversation on how higher education and its partners can build better support systems for students, particularly women.

This chapter presents a discussion of the study results as they relate to the limited existent literature and the study hypothesis. Results are related to the existing barriers for women and to the conceptual framework. Based on both the statistical results and participants' comments, implications for institutions developing internship programs are discussed, followed by the limitations of this study. Recommendations for future research are given and final conclusions are drawn.

Findings

The current study sought to answer two questions, the first focused on the importance of the multiple elements of the LARSS internship, e.g., mentor, research project, networking, etc. and the second focused on the skills for the workplace, referring to the skills acquired during the internship and their importance in the engineering field.

This section presents a discussion of these results situated in the existing research on each topic. Dispersed throughout the following paragraphs are quotations from the free comment space provided on the survey. Forty one percent of the men contributed comments on a variety of topics related to the survey and 47.5% of the women contributed comments.

Internship differences

Question one asked if there is a difference in the perceptions of men and women regarding the importance of eight different elements of the internship. Specifically, the question asked what elements of the internship are perceived by women as most important in preparing women for a profession in engineering as compared to those that are perceived by men as most important in preparing men. This question was analyzed with a multivariate t-test which shows a significant main effect for gender (Hotelling's Trace = .126, $F(8,153) = 2.413$, $p = .018$, partial $\eta^2 = .112$). Further analysis revealed that there is a significant difference between women and men's perceptions of the importance of the mentor ($F(1) = 3.857$, $p = .051$, partial $\eta^2 = .024$) and the research experience ($F(1) = 6.844$, $p = .010$, partial $\eta^2 = .041$).

Men's ($M = 4.325$, $SD = .844$) higher rating of mentoring compared to women's ($M = 3.993$, $SD = 1.150$) suggests that men perceive mentoring as more important in preparing them for an engineering profession than women perceive it. This finding is consistent with Chesler and Chesler (2002) who found that the dominant mentoring style in engineering is "based on a traditional model of male socialization" (p. 51). This style very often supports the development of masculine traits, such as those that are more technological, focused on technical problems, intellectual challenges, and career development (Chesler & Chesler, 2002). In contrast, traits that are often considered more feminine, such as those that are psychosocial, dealing with social conflicts, work/home balances, development of confidence, courage, and personal growth, are less likely to be the focus of the mentor-mentee relationship, particularly in a field such as engineering (Chesler & Chesler, 2002). In the open response space on the survey, many of the males wrote about their mentor. For example, "My mentor…made all the difference. His natural ability to guide students without overly constraining creativity was brilliant;" "I cannot stress how good all of my mentors were through the program…" and "The internships had amazing mentors…" Some males reported they are still in contact with their mentors and only two reported anything less than an excellent experience with their mentors. In contrast, only two females offered any comments about their mentors, and neither of these were specific to the relationship with the mentor, but more about the work experience under the mentor. As a descriptive point, only 11 of the men had female mentors, the remaining 111 had male mentors and nine of the women had female mentors, while the remaining 31 had male mentors. "Great mentors are critical to the success of a LARSS student's experience" reported one male participant. Such sentiments were not expressed by any of the females.

What is not known is whether or not there were differences in the interactions between mentors and male and female mentees during the internship. Were both given the same types of opportunities with their mentors or were these experiences different? Did both have the same expectations of their mentor or were these different? How did each define the role of a mentor and were these definitions similar or not? Essentially, such questions seek to determine if the differences between women and men are based on actual experiential differences or on different perceptions and/or expectations. Questions such as these would best be answered qualitatively, through interviews with the respondents. This line of inquiry is a possible area of future study.

The cultural style of technical mentoring, much like other aspects of engineering, is masculine, favoring technical conversations over psychosocial conversations (Chesler & Chesler, 2002). Reporting on research done by David J. Shernoff, Drew (2011) provides a list of six elements necessary for a successful mentorship: balance between guidance and freedom, consistent accessibility, adequate resources, specific, positive feedback, individual attention to the intern, and for graduate students, treatment as "respected collaborators" (p. 109). Many of these elements relate to the technical aspects of the internship, such as balancing guidance and freedom, resources, specific feedback, and treatment as a collaborator. Other elements could be viewed as either technical or psychosocial, depending on the content of the interaction, such as consistent accessibility and individual attention. Only the idea of positive feedback speaks to the psychosocial needs of the intern (Chesler & Chesler, 2002; Drew, 2011). Particularly in a masculine field like engineering, mentors are more likely to be using masculine techniques; techniques that are less likely to provide the type of support most noted to benefit women.

The second finding of this question was that men ($M = 4.572$, $SD = .641$) rated the importance of participation in a research project higher than women ($M = 4.225$, $SD = .947$) rated it. For both genders, this element had the highest means, but the mean for men was significantly higher than that for women. This finding is supported by research on the importance of experience in the field in making decisions about a future career

(Burke & Mattis, 2007; Ciot & Ciot, 2010; Doel, 2009; Kardash, 2000). Written comments regarding the research project were well distributed across males and females. Both genders cited the value of a research intensive experience, learning about the tools of the field, and the work environment as they participated in actual research. "LARSS was valuable in helping me understand the environment of engineering research" reported one male participant. One woman commented that "LARSS taught me to relax and enjoy the work and experience in addition to doing the job. It is GREAT to enjoy what you do and LARSS taught me that there are opportunities to do that!" and another woman, speaking to the influence the research project had on her future said, "I have decided to pursue a career in what I worked on at NASA with my mentor, and I am currently studying the subject in graduate school, to get my PhD in that subject. Thank you for providing me with such a life-altering summer!" Comments such as these clarify the importance of the research project in guiding the future of some interns. However, for others, the research project did not have such a positive impact.

Some experiences may actually push students away from the engineering field, instead of drawing them toward it (Burke & Mattis, 2007). One male participant shared his negative experience. "The involvement from research teams was based on our initiative in seeking out challenges and work...I had hoped I would have been involved in more realistic and challenging tasks..." and another who, without providing any details, shared that she believes her "bad experience at Langley was unusual." Although there were very few negative comments, these remarks remind the reader that it cannot be assumed that every research project is a good match for every intern, female or male. It is essential that in establishing internship experiences, differences based on gendered socialization and individual differences are considered in internship placement.

Comparing the preferences of men and women based on gendered socialization, women and men respond to stimuli differently (Chesler & Chesler, 2002; Gillman, 1993). For example, women are likely to prefer encouragement, non-aggressive challenges, and peer collaboration while men may prefer to be aggressively challenged, tested, and to compete with their peers (Chesler & Chesler, 2002; Gilman, 1993; Goodman et al., 2002). Women develop self-efficacy from vicarious experiences and social persuasions, while mastery experiences are most important to men (Zeldin & Pajares, 2000). Women tend to focus on their failures, while men focus on their success (Adelman, 1998; Seymour & Hewitt, 1997). Women tend to prefer ways of knowing that are connected to doing and learning in community, while men tend to be comfortable with separate ways of knowing (Belenky et al., 1986). As women and men enter the internship, they bring with them these gendered differences; differences that may or may not be understood by the mentors and research teams they will join. As one considers the results of the current study, such gendered differences need to be considered, not only in interpreting the results, but in identifying the questions that need to be asked in the future. Do these gendered differences play a role in the differences between men and women's interpretations of the importance of the research project? Did women find encouragement and support in their research projects, or did they find a competitive, aggressive environment? Based on comments, it appears that the environment was supportive for most women respondents, as many reported that the experience built their confidence and interest, indicating that the needs of many women are being met in the internship. But much more information is needed to truly understand the experience of women in the engineering internship.

Nominally, women and men in this study had different ideas about what was most important in the internship. Namely, for men, technical aspects of the internship were more important than social aspects, as was evidenced by their focus on the experience with the project, the mentor and the technical writing. This preference was consistent with the culture of engineering, which favors technical skills; not only the demonstration of them, but the desire to discuss them at length and be immersed in them (Robinson & McIlwee, 1991). Namely, women saw the research project, networking, and mentoring as the top three in importance while men saw the research project, mentoring, and technical writing as most important. This focus is consistent with the culture of engineering, which favors technical skills; not only the demonstration of them, but the desire to discuss them at length and be immersed in them (Robinson & McIlwee, 1991).

The top three elements of the internship for women demonstrate the importance of both technical and social experiences, both of which are necessary for a successful engineering career (Faulkner, 2007). The importance of networking for women is consistent with the literature, which suggests that a sense of community and the development of relationships are important to persistence through the degree program (Zeldin & Pajares, 2000). The high mean for the research project reflects the importance of learning by doing, through experience in the field - the only place where much of the expertise required for the field can be acquired (Belenky et al., 1986; Faulkner, 2007; Felder, 1995; Lombardi, 2007). But networking, a social activity in the LARSS internship, reflects the importance of social interaction with others in the field, of a sense of community (Zeldin & Pajares, 2000). Networking in the LARSS internship is not focused on technical interactions, but on social events. These activities include picnics, bowling, going out to the movies, and other social activities. These skills are important to the social obligations of an engineer (Faulkner, 2007), but also in creating a web of relationships on which the blossoming engineer can rely for support (Gilligan, 1993), both in the internship and beyond it. The importance of developing relationships with others in the field, both in building a network and in interactions with a mentor are also important for female engineers, including those in this study (Faulkner, 2007; Felder, 1995; Goodman et al., 2002; Zeldin & Pajares, 2000).

Skills preparation for an engineering career

Question two asked what skills are developed in the internship that support women's persistence into an engineering field as compared to the skills that support men's persistence. This question was analyzed through 2x2 Repeated Measures Multivariate Analysis comparing women and men's perceptions of the importance of each of 20 skills, based on the 21st Century skill set, in an engineering field and the effectiveness of the internship in developing each of these skills. This analysis was followed up with univariate statistics to examine the relationship between the importance of the skills in the engineering field and the effectiveness of the internship in developing them.

The 20 skills considered in this analysis can be broken into four groups: critical thinking skills, professionalism, communication/collaboration, and technical/STEM specific skills. Each of these sets can be found in the following tables (Tables 5.1-5.4) with the means and standard deviations of women and men for both the importance of the skill in an engineering job and the effectiveness of the internship in developing the skill.

Table 5.1: *Critical Thinking Skills for Women and Men*

Critical Thinking Skills	Importance of the skill in an engineering job		Effectiveness of LARSS to develop the skill	
	Women	Men	Women	Men
Critical thinking	4.52 (.628)	4.49 (.631)	3.71 (.857)	3.49 (.878)
Exercising sound judgments	4.09 (.676)	4.23 (.707)	3.27 (.943)	3.18 (.904)
Making sound decisions	4.09 (.675)	4.22 (.801)	3.18 (.880)	3.15 (.803)
Solving problems	4.49 (.687)	4.57 (.627)	4.03 (.899)	3.61 (.991)
Creativity	3.50 (.969)	3.72 (1.033)	3.50 (.967)	3.28 (1.147)

Table 5.2: *Professional Skills for Women and Men*

Professionalism	Importance of the skill in an engineering job		Effectiveness of LARSS in developing the skill	
	Women	Men	Women	Men
Time management skills	3.92 (.958)	3.94 (.973)	3.25 (1.026)	2.77 (1.034)
Appreciation for diversity	3.23 (1.085)	2.85 (1.166)	3.20 (1.144)	2.79 (1.119)
Professional behavior	4.11 (.892)	3.78 (.981)	3.89 (.921)	3.46 (.971)
Work independently	4.05 (1.092)	3.89 (.956)	4.07 (.874)	3.96 (.999)
Leadership skills	3.44 (1.003)	3.41 (.991)	2.90 (.919)	2.63 (1.171)
Lifelong learning skills	4.16 (1.092)	4.22 (.875)	3.90 (1.037)	3.55 (1.068)

Table 5.3: *Communication and Collaboration Skills for Women and Men*

Communication/ Collaboration	Importance of the skill in an engineering job		Effectiveness of LARSS in developing the skill	
	Women	Men	Women	Men
Written communication	4.23 (.696)	4.18 (.891)	3.35 (.917)	3.20 (.999)
Oral communication	4.36 (.728)	4.25 (.778)	3.38 (1.002)	3.23 (.960)
Collaboration	4.30 (.910)	4.23 (.836)	3.31 (1.028)	3.33 (1.043)
Adaptability	4.01 (.877)	3.84 (.936)	3.19 (1.039)	2.77 (1.136)
Teamwork	3.82 (1.064)	3.36 (1.169)	3.19 (1.241)	3.34 (1.146)

Table 5.4: *Technical and STEM Specific Skills for Women and Men*

Technical/STEM Specific Skills	Importance of the skill in an engineering job		Effectiveness of LARSS in developing the skill	
	Women	Men	Women	Men
Analysis	4.32 (.663)	4.27 (.754)	3.95 (.981)	3.59 (.902)
Computation skills	3.77 (.972)	3.83 (1.028)	3.16 (.988)	3.30 (1.130)
Computer skills	3.97 (.898)	4.12 (.792)	3.33 (1.168)	3.40 (1.185)
Technical skills	4.27 (.590)	4.23 (.806)	3.45 (.881)	3.49 (.997)

Before looking at the results of the multivariate analysis, it is important to note the small number of women eligible for this analysis. To be included, each respondent had to be in an engineering position at the time he or she completed the survey. This allowed for an accurate comparison of the needs in an engineering field and the effectiveness of the internship. The result of limiting the population to only those working in an engineering field was that the population of women was reduced to 27, below the preferred number for analysis, which is typically 30 (Fraenkel & Wallen, 2006). This under-powers the variable for gender; therefore results need to be interpreted with caution.

Results of the analysis suggest that there are no significant differences between women and men's perceptions of the importance of the skills and the effectiveness of the internship in preparing them in the skills. There was, however, a significant difference between the importance of the skills compared to the effectiveness of the internship (F $(20,88) = 8.694$, $p = .000$, Wilks' Lambda = .336, partial $\eta = .664$). Follow-up univariate statistics identified that for 17 of the 20 variables, the internship did not adequately prepare the intern for the skill in the field. Only for creativity, diversity, and independence did interns think they were adequately prepared.

For all of the skills, the means for effectiveness of the internship hovered around the effective to very effective range, with a few in the somewhat effective to effective range and a few in the very effective to extremely effective range. However, these ratings of effectiveness were lower than those obtained by Wright et al. (2007) in their 10 year study of a biomedical engineering internship, which ranged between four and five on a similar five-point Likert scale. Both internships were evaluated with a survey; the biomedical engineering internship used the ABET skills as the basis for their survey, and LARSS used the 21st Century skills for theirs. As previously noted, these skill-sets are very similar. Like LARSS, the biomedical engineering internship program included practice in communication, a research project, tours and demonstrations, lectures, and social networking (Wright et al., 2007). However, a key difference between these two internship programs was that the biomedical engineering internship provided specific instruction through courses on site at the beginning of the internship (Wright et al., 2007). These courses, taught be faculty and staff at the Laboratory of Reparative Biology and Bioengineering, part of a cancer center affiliated with the University of Texas, provided scaffolding, ensuring that all students received basic instruction and experience in the skill sets expected for the internship (Wright et al., 2007). Such courses may have contributed to the higher means reported on their survey, as compared to the LARSS survey.

The results for teamwork raise some interesting questions. Women rated the importance of teamwork higher than men ($\bar{X}$=3.82 compared to $\bar{X}$=3.36) and the success of the internship in developing teamwork lower than men ($\bar{X}$=3.19 compared to $\bar{X}$=3.34). What is most interesting about this finding is the difference in the size of the gaps between importance and effectiveness. For women, there is a significant gap between the two, but that gap is negligible for men, who perceive that the internship prepared them nearly enough for the field. Women on the other hand, perceived the skill of teamwork as much more important than their preparation would suggest. The literature speaks to the importance of this skill (Casner-Lotto & Barrington, 2006), yet what can account for this disparity between women and men's perceptions? An interpretation might be that because women value teamwork more than men, they are more attuned to opportunities to bolster this skill and more aware when the activities do not support the acquisition or practice of this skill.

Appreciation for diversity is another skill that raises questions. As with other skills, the ratings for the effectiveness of the internship in developing an appreciation for diversity were also low, with a mean of 3.20 for women and 2.79 for men. However, this skill was rated for importance in the field lower than any other skill by both women ($\bar{X}$=3.23) and men ($\bar{X}$=2.85). What could account for such a lack of perceived importance? McIntosh (1988) suggests that this could be the result of white privilege, the unconscious oppression of another social group through unacknowledged privilege. Many white men and women are unaware of the assets they have simply by nature of being white (McIntosh, 1988). "Whites are taught to think of their lives as morally neutral…and also ideal, so that when we work to benefit others, this is seen as work which will allow "them" to be more like "us" (McIntosh, 1988, p. 1). With such a mindset, it may be difficult to see the benefits of diversity and reduce the likelihood that it will be valued in the workplace. Further study is necessary to determine the extent to which white privilege is a problem in the engineering field, but based on the results from this study, this is an area of concern.

Looking across the skills data in and beyond the LARSS internship it is clear that additional information is needed to determine if there are gender differences between women and men's perceptions of these skills. First, did men and women share similar definitions for each of the 20 skills? Was the experience of women similar to that of men in the internship for each of these skills during the internship? More accurately, did they have the same expectations for the same skills? In what type of engineering was each participant working? The type of engineering and even the role of the engineer can have a significant impact on the type of work that the individual does. These are areas in need of further study.

Overcoming Barriers for Women

> *I felt that through the program I was able to grow not only academically and professionally, but also as an individual. Through the program I became a more outgoing and confident person. This along with the professional and engineering skills that I was able to develop through the session has benefited me in my other internships and continues to benefit me in graduate school. I was also able to make great professional contacts through the internship that I continue to keep in touch with.*

This quote from a female respondent demonstrates the impact the internship can have in overcoming barriers to success. She speaks of internal changes, becoming more outgoing and confident, and developing new skills; and external rewards, developing a professional network. Overall, the experience has helped her in graduate school and other internships. This section focuses on the women who participated in this study and presents descriptive statistics and summaries in order to identify trends and areas of strength and weakness that students noted of their experience. Areas for future exploration are identified.

Looking only at women respondents in this study, there are some elements of the internship that appear to be more important than others (See Figure 5.1). On the survey, the research project, networking, and mentoring were rated by women as the top three elements of the internship, followed by technical writing and the on-center tour. These elements represent a blend of technical and social aspects of the internship (Faulkner, 2007). Frequently it has been suggested that women are social and men are technical; some argue that they are socialized to fit these roles (Bystydzienski & Brown, 2012; Faulkner, 2007; Robinson & McIlwee, 1991). The demarcation of engineering as a masculine field is in part based on the focus of engineering on technology since its creation (Robinson & McIlwee, 1991). Such gender assignments create barriers for women trying to prove themselves in a technical field (Faulkner, 2007). The results from this limited sample do not support such a dualistic view of men acting in one manner and women in another. Instead, it appears that women have both technical and social interests related to the field of engineering, and these needs are equally important to their development as engineers. Faulkner (2007) confirms this idea, suggesting that often the women interested in engineering are interested in the technical aspects of the field. She suggests encouraging an image of engineering that is both social and technical. Such a focus breaks down identity boundaries that have historically limited women. According to the current study, the internship experience supports the development of social and technical skills, both of which are appreciated by women in engineering.

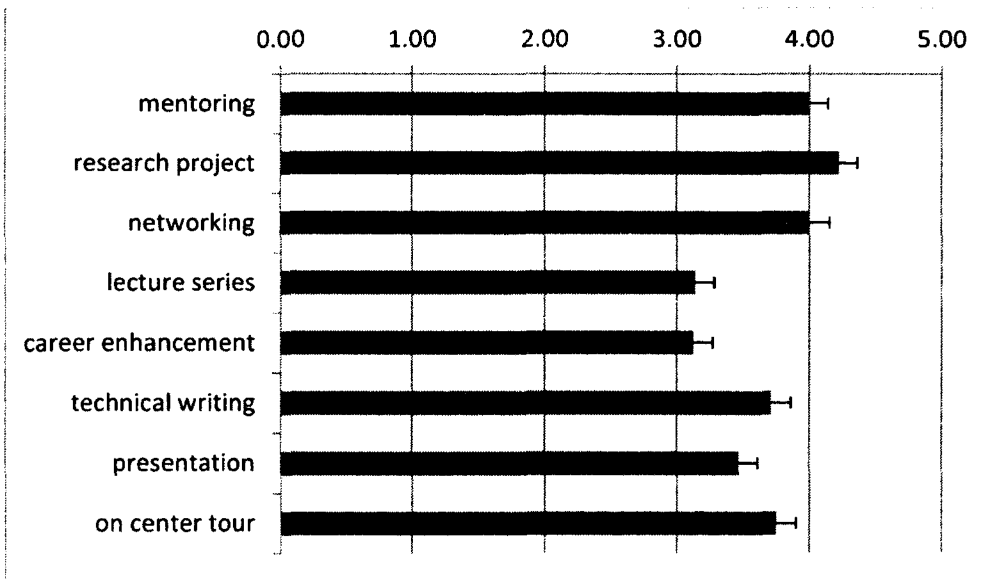

Figure 5.1: Women's Perspectives on the Elements of the Internship

The development of skills during the internship supports women as they overcome barriers related to interest, experience, and isolation. The number of women respondents included in the skills portion of this study was only 27. This small size reduces the power of inferential analysis. Nevertheless, the descriptive data can be used to identify some of the experiences of this population during the LARSS internship.

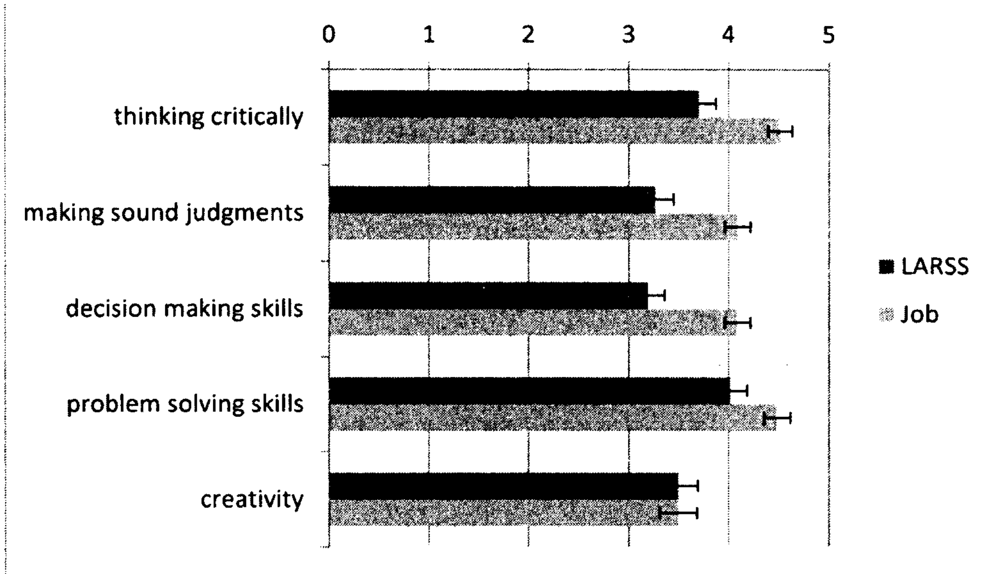

Figure 5.2: Effectiveness of LARSS in Critical Thinking Skills Development (Women)

Women participants from the LARSS internship found the internship effective to very effective in developing skills in critical thinking (See Figure 5.2). They found opportunities to use all five of the skills, although, with the exception of creativity, these experiences were not enough to prepare them for the expectations of the field.

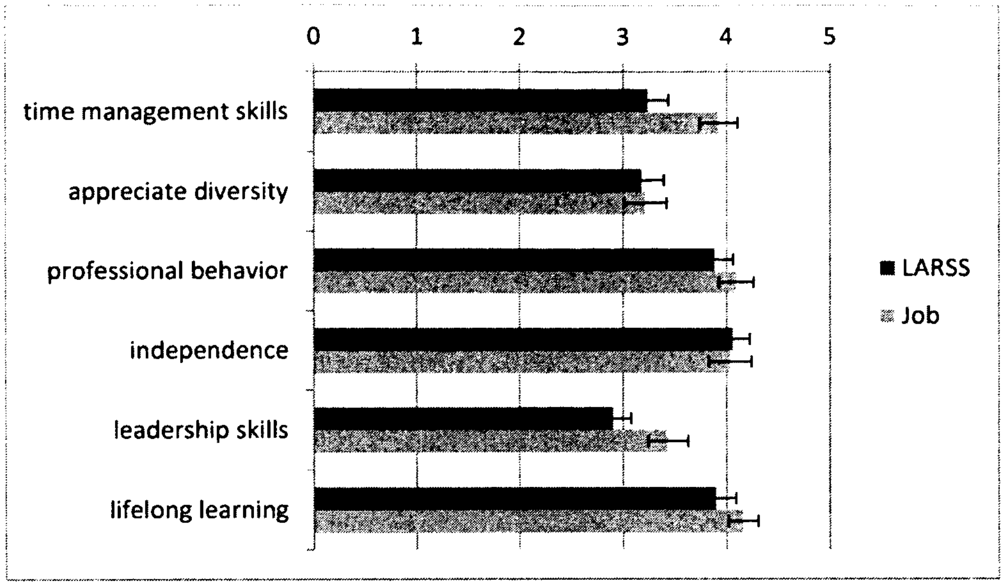

Figure 5.3: Effectiveness of LARSS in Professional Skills Development (Women)

Looking at the professional skills, women respondents reported the internship was only somewhat effective to effective in developing leadership skills, but it was very effective in developing independence (See Figure 5.3). Only in developing an appreciation for diversity and developing independence was the internship effective in preparing the women for their engineering careers.

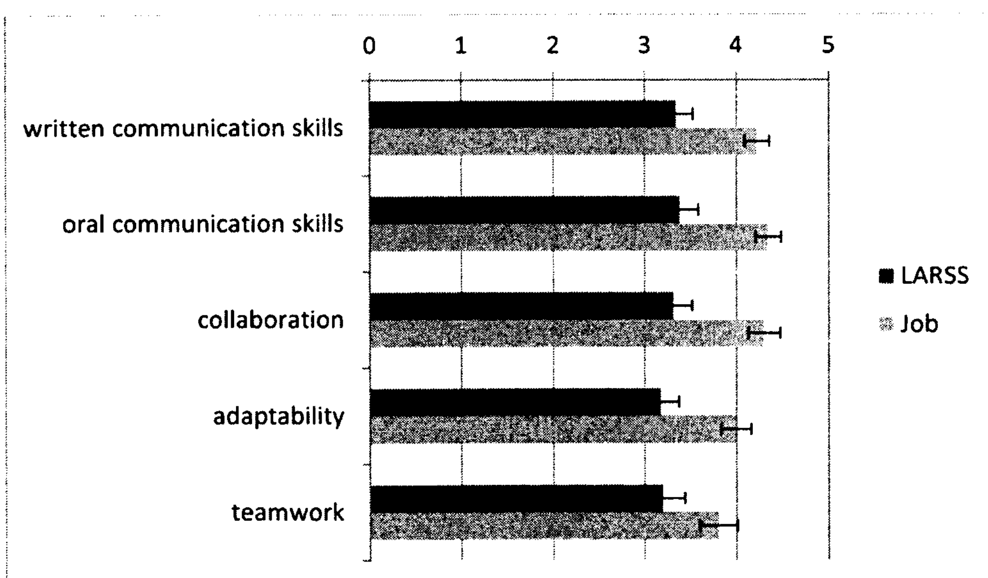

Figure 5.4: Effectiveness of LARSS in Communication/Collaboration Development (Women)

Communication and collaboration skills are often considered strengths of women (Chesler & Chesler, 2002; Gilligan, 1993). However, although women cited the internship as effective in developing these skills, they did not feel that the internship had effectively prepared them for the workforce in any of these skills (Figure 5.4). The low means for the effectiveness of LARSS in this skill set raise several questions. Was it assumed that women were strong communicators, or were they supported in these skills? Did these women perceive that they were in need of certain types of communication skills, perhaps related to technical communication? Did mentors assume that the women would create their own teams and collaborations or did they invite them into their networks? Did women have the opportunity to work on research teams or were they encouraged to do more work on their own? Does low self-efficacy prevent these women from fully participating in collaborations, as was the case in the collaborative classroom (Felder, 1995)? Follow-up interviews would help to answer some of these questions and more clearly identify the issues facing these women during their internships.

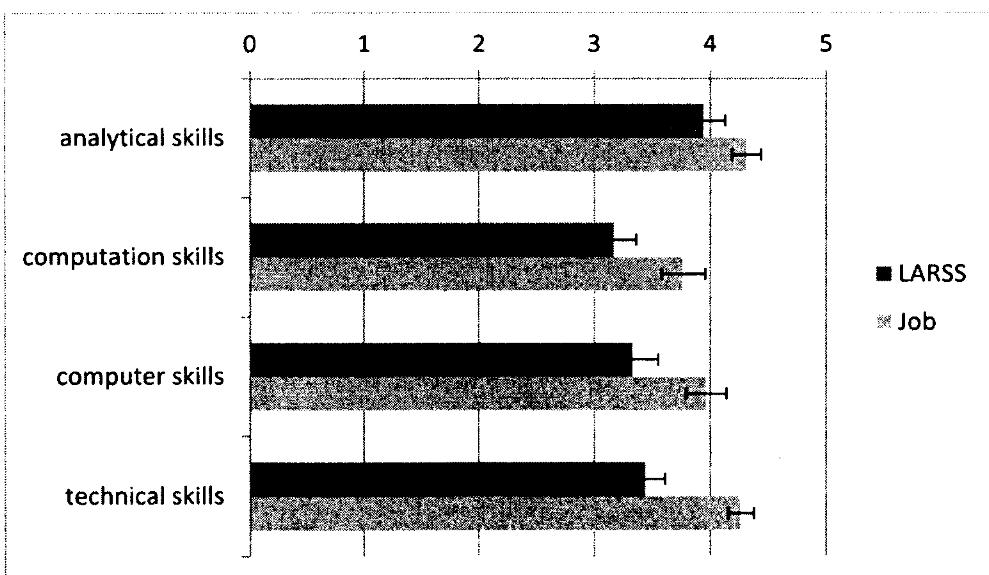

Figure 5.5: Effectiveness of LARSS in Technical/STEM Skill Development (Women)

Finally, looking at the technical skills, women respondents found the internship to be most effective in developing their analytical skills (See Figure 5.5). The decreasing means for the other three skill sets raise additional questions about how the women defined these skills: how did they operationalize technical skills? Did they see these as related to the use of equipment or tools? Or were they connected to specialized computer programs necessary for the unique tasks they were doing? What does 'computer skills' mean? Answers could range from typing speed, to basic word processing systems, to engineering software, to computer programming. Future studies would need to clearly define what is meant by terms such as these to ensure that all respondents are using the same definition. Without knowing how these terms were defined by respondents, no conclusions can be drawn about the effectiveness of the internship in developing these skills.

Looking at the barriers to women through the lens of the LARSS internship raises more questions than answers. As an exploratory study, this is not a tremendous surprise. One of the goals of such a study is to draw out the questions that need to be asked, and this analysis has drawn out several.

Results Related to Tinto and Pusser's Model

The three overlapping rings of Tinto and Pusser's (2006) model representing support, involvement, and feedback are all strengthened through the internship and the partnerships produced between higher education and industry. Through institutional commitment and the development of strong internship programs in business, industry, and government (herein referred to as industry), the internship and its parent institutions contribute to overcoming the internal, external, and cultural barriers against women.

Support

Support includes mentors, role models, research team members, and peers. Related to support, women in this study valued networking and mentoring and considered these as some of the most important elements of the internship. Networking opportunities were extremely valuable, providing support from peers within similar academic fields from different schools, providing opportunities to work with people that were highly admired, and leading to relationships that continued well beyond the end of the summer. "I am in touch with fellow LARSS interns to this day." "I was also able to make great professional contacts through the internship that I continue to keep in touch with." All of the women had at least one mentor and nine of the women (about 23%) worked with a female mentor. One woman said of her female mentor, "My mentor was wonderful and allowed me the freedom to do the work I wanted." For at least one intern, the experience with her mentor (male) was life altering, resulting in a new career direction, based on her research during the internship. Role models were found in peers and professionals who inspired and supported interns, not only during the internship, but beyond it as well. "I met a friend that showed me Stanford and convinced me to apply…and now I am getting a PhD from it!!!" The importance of networking and mentors is evidenced throughout the survey questions considered in this study and suggest that the support provided in the internship can have a strong influence on students' future plans to enter the workforce.

Involvement

Involvement includes being a member of a research team, interaction with equipment, and the collision of theory with real world application (Doel, 2009). Women considered being part of a research team as the most important element of their internship experience. Women who were working in engineering fields at the time of the study rated collaboration as very important (M=4.3045; SD=.9098) for their jobs, and teamwork as important (M=3.8230; SD=1.0644). Comments about the internship speak to the research experience, learning what it is like to work in industry, and more specifically at NASA. This focus on experiential learning is consistent with Belenky et al.'s (1986) work suggesting that women learn procedural knowledge through personal experience, which the authors refer to as connected knowing. This type of learning applied to female engineers' rating of technical skills as very important for their jobs (M=4.2716; SD=.5904) and comments about these skills, such as "The LARSS internship allotted me the knowledge and experience needed to pursue my current career as an Aeronautical Engineer" and "LARSS did an incredible job exposing students to all facets of engineering and scientific research." Consistent with the research (Bystydzienski & Brown, 2012; Cech et al., 2011; Pinelli & Hall, 2012), the opportunity to be a part of real research that makes a difference in the world and to collaborate was found to be important to the women in this study.

Feedback

Feedback refers to information about the student or the field based on interactions with the mentor, research team, peers, or home higher education institution. Feedback was not directly measured in the survey, although it was a part of the presentation and technical writing processes. Women rated these elements in the middle of the eight elements. However, because these experiences were presented as complete experiences, it is impossible to determine the value of the feedback provided during the process of preparing for either of these elements of the internship. Some of the comments confirmed the importance of the experience in helping interns make decisions about their future based on the feedback they received while in the internship. For example, one female intern noted that "LARSS was my first research experience and it helped me realize I would need a graduate degree to pursue research;" and another found confirmation of her career choice, "My experience at LARSS confirmed my desire to be an engineer, and to work in industry." Although this feedback is not specific to any individual encounter, it is a sign that the overall experience does provide an almost systemic type of feedback that informs decisions for future work in the field. Although the feedback in this study was very positive, one concern with feedback of this type is that women may be making decisions based on systemic feedback from a very limited experience (Lichtenstein et al., 2009), and they may be as likely to leave the field as they are to stay in it, especially if they do not have opportunities to interact with others in the field who can attest that not all engineering experiences are the same as theirs. Looking at this systemic feedback from the outside provides some insight into the culture and context in which the internship exists.

The three overlapping rings in Tinto and Pusser's (2006) model provide the ideal framework for the development of the internship because the internship enhances each of the interlocking circles of support, involvement, and feedback. The means to overcome the existing barriers to women in engineering can be found in the role of the internship as it relates to Tinto and Pusser's (2006) model. Within each of the overlapping rings internal, external, and cultural barriers can be overcome through the internship. As institutions consider the needs of women in their engineering programs, they need to ensure that women are given support, adequate involvement, and appropriate feedback so that they can overcome the barriers to their success in the field and make informed decisions about their future.

Implications for Practice

For higher education institutions with engineering programs, institutional change may need to focus on smaller aspects of the program, building a system of change that moves from local programs or departments, across the engineering school, and eventually across the entire institution (de Pillis & de Pillis, 2008). One example of a program change that can have far reaching effects is the development of the engineering internship program. As the program is developed, partnerships are created with business, industry, and/or government agencies (Ciot & Ciot, 2010). As these partnerships develop, the needs of the field become more apparent to the academic institution and measures can be taken to ensure that the academic program is aligned with the needs of the employers. The results of the present study confirm that the 10 week internship is not enough to prepare interns, male or female, for the needs of a career in an engineering field.

Collaborative Partnerships

If the ten-week internship experience in a top ranked organization is not enough to prepare interns for the workforce, then what is? What could strengthen such an experience? One option is collaboration between the sending universities and colleges and the industrial partners such that students are intentionally developing the necessary workforce skills in the classroom through authentic learning opportunities and reinforcing them in the internship. Tighter coupling of the higher education engineering program with the industry, business, and government organizations that students intern with could enhance the ability of higher education to prepare students for the unique needs of the workforce. The results from this study suggest that currently, students are not fully prepared for the challenges they will face in the field, and the internship experience alone cannot prepare them With a tighter coupling of academics, internships, and business/industry needs, a more fully trained workforce can be prepared for the future. One example of a tightly coupled system is the TIP program, in which a university and community college partner to provide two semesters of coursework to prepare students in communication skills, technical skills, and teamwork before placing them in summer internships where they apply these skills in a real world context (Croissant et al., 2000). Regular feedback is gathered from industrial partners to ensure that the needs of industry are being met by the students and that the students are adequately prepared (Croissant et al., 2000). This type of collaboration was not evidenced in the current study.

Technical and Social Skills

As engineering programs develop partnerships with industry for their internship programs, they need to ensure that they consider technical and social aspects of the internship (Faulkner, 2007). This focus on technical and social skill development is critical in overcoming gendered stereotypes for both women and men, and for ensuring that all interns are given opportunity to develop skills that are important for the success of an engineer – not all of which are technical. One of the questions that arose from the current study is what is the role of each respondent who is working in an engineering field? The answer to this question could have a significant impact on their rating of the effectiveness of the internship to prepare them for the role. For instance, many engineers move into management roles where they are more likely to depend on written and oral communication skills than computational and technical skills (Faulkner, 2007). One might assume that only those who plan to move into management need to develop such skills. Yet, most managers are former engineers who have climbed the ladder to reach these managerial positions, suggesting that skills which may not be as important in the managing role were important in getting to the management role (Faulkner, 2007). In addition, for many types of engineering, it is necessary for the engineer to interact with others in and out of the field, confirming the importance of communication skills for all engineers. This is just one example of a skill set that is necessary for the social and technical success of an engineer. Further study is necessary to determine the most effective ways to prepare interns for the many technical and social skills needed in the workforce.

Developing internships that support women does not mean that these internships should be completely different from those that support men. Although the results should not be over-generalized, the current study suggests that men and women recognize they need the same skills. If this finding holds true through additional research, then there should be a good deal of overlap in the elements and skills covered in the internship, as both men and women need the same skill sets to succeed in engineering (Faulkner, 2007). However, implementation should be more gender neutral. For example, mentors should be trained to support not only the technical development of the student, but also the psychosocial needs of the student (Chesler & Chesler, 2002). Alternative models for mentoring should be incorporated, such as multiple mentoring or collective mentoring in which communities or teams of people are involved in the mentoring of interns (Chesler & Chesler, 2002). Such models do not take away the technical aspects of the mentor-mentee relationship, but rather expand on the existing model in a way that supports a diverse population of engineering interns. There are numerous possibilities in the development of future internship programs, however, to ensure that the needs of a diverse population of engineering students are being met, it is essential that further research be completed on the subject of internships; in particular as relates to the needs of women and men.

Internships for Success

Putting mentoring and the research project in the context of Tinto and Pusser (2006), the mentor provides support and feedback, and oversees the intern's involvement in the field. Having a mentoring team increases the value to each of these areas, providing more of all three. The research project provides an opportunity to get involved in authentic research, applying theory to real world problems. The project is often done in collaboration with other engineers, scientists, technicians, etc., providing the opportunity to work with others on a research team, a source of support for the intern. Finally, through interactions with the mentor and/or members of the research team, interns are given feedback on their work, feedback which is critical for the intern to determine how well she is doing in her work and development.

As relates to overcoming barriers to women, the mentor and the research experience can both be developed in such a way as to support women in overcoming the internal, external, and cultural barriers that are often found in engineering. The development of alternative models of mentoring as well as training for mentors in the standard model can enhance women's self-efficacy as they are given adequate support to complete the tasks in the field, provide adequate support - particularly if a female is on the mentorship team who can provide insight into some of the informal challenges for women, and decrease alienation as the intern becomes part of a larger group dedicated to her success (Chesler & Chesler, 2002; Seymour & Hewitt, 1997). A mentorship team has the potential to reduce competition and develop instead a collaborative, safe environment for the intern to explore and develop. The research experience provides an authentic experience, with the potential to develop interest in the field, access to the tools and equipment of the field and through collaboration, opportunities for support and cooperation (Ciot & Ciot, 2010; Croissant et all,. 2000; Lichtenstein et al., 2009; Ruiz et al., 1999; Wright et al., 2007).

Combining aspects of the original Tinto and Pusser (2006) model with evidence from the literature and the current study, a new model was created to explain the role of the internship in engineering persistence for women (See Figure 5.6). At its core is still the interplay between support, interaction, and feedback, but in this model these three factors are situated over an arrow representing the internship, suggesting that the development of this triad is dependent on not only what happens within the internship, but also what is contributed by the institutions to the internship. The dynamic nature of the context matters. In the end, a host of factors influences the internship experience. For success in any of the three areas within the triad, there must be commitment from institutions to work together, to provide training and support to those who will be working with interns, and to evaluate and make changes as necessary. These are not part of the internship directly, but rather require an institutional commitment from both higher education and industrial partners to not just provide internship opportunities, but to fully develop, monitor, and adapt these internships to the needs of a diverse population of interns. As each institution works to develop the triad, they receive the benefit of improved output, enhanced learning, and a stronger, more prepared workforce.

The remainder of the model is unique to the interplay between the support, interaction, and feedback of Tinto and Pusser's (2006) model, the barriers that exist for women, and the internship. At the base of the model are the barriers that exist for women; internal, external, and cultural. Overcoming these barriers and improving persistence into the field is the primary goal of this study and therefore the barriers are found beneath the body of the model. Situated above these barriers are the academic engineering program and the partner in industry, government, and/or business. These form the foundation on which the rest of the model is built, contributing to both the engineering education and workforce development of the engineering students, both women and men. Where these two come together is the internship, a long arrow coming up out of this relationship and moving far beyond these institutions into the engineering field of the future. In order for the internship to be effective, the higher education institution must demonstrate institutional commitment, maintain an expectational culture, focus on technical and social skill development, and be committed to the careful development of each internship partnership. For the industry, there must be evidence of support for women; examples being female role models, a cooperative, integrated environment, and the inclusion of women in solving real world problems; as well as a focus on technical and social skill development. As previously mentioned, the support, feedback, involvement triad rests upon the arrow moving through the internship, but below it are arrows going up and down between the higher education engineering program and the triad and between the partnering institution and the triad, suggesting that there is a dynamic relationship between each institution and the triad. When all of these elements come together, women are able to persist into an engineering field.

It should be understood that a problem at any one of the points in the model may have a profound effect on an intern, for whom this internship may be the only experience on which she is making decisions for her future. It is critical that engineering academic programs and industry carefully plan and coordinate to ensure that students are given the support they need, the opportunities to experience the field, and the feedback to reflect on about their experience. Through the careful development of engineering internships, more women may develop an interest in this field that has been dominated by males for far too long. Once women can break into engineering in critical enough numbers, changes will become easier as the engineering workforce begins to diversify and develop into a field representative of all people, solving the problems of a diverse population. The internship experience can help shatter existing barriers, providing support, involvement, and feedback to a population whose ideas and creativity are so desperately needed in the engineering workforce of the 21^{st} century.

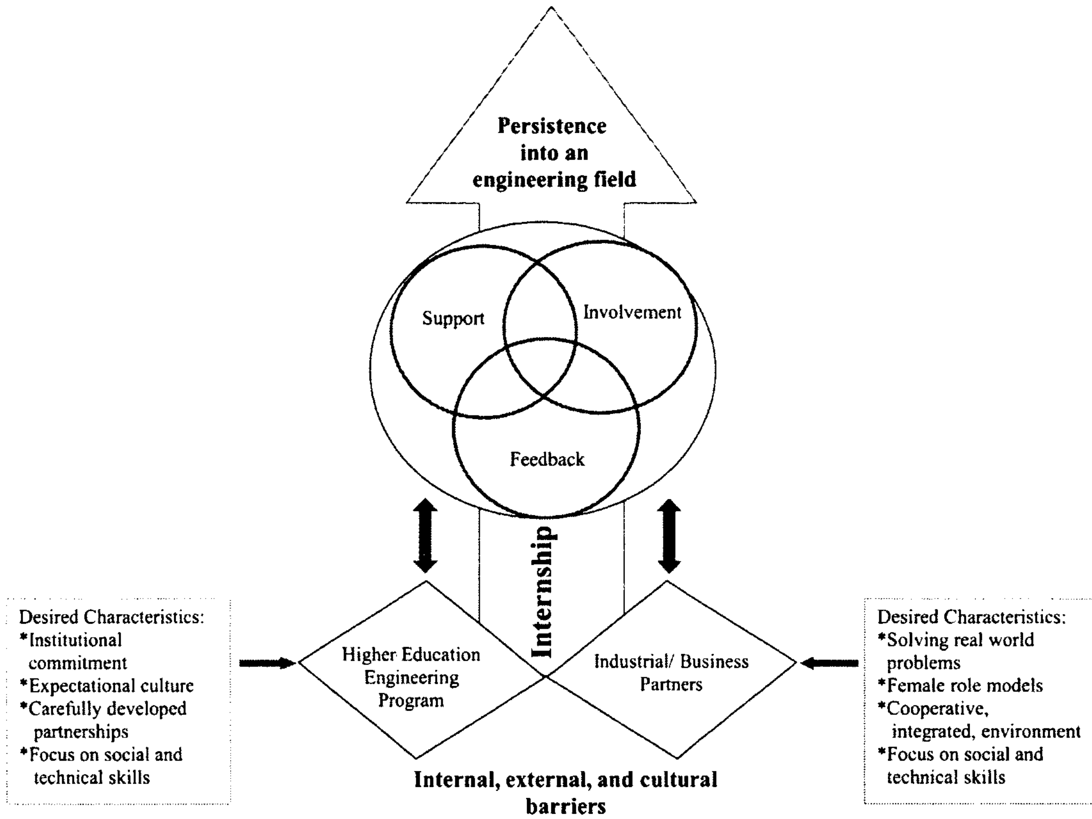

Figure 5.6: The Place of the Internship in Engineering Persistence for Women

Limitations of the study

The current exploratory study asked two primary questions which were analyzed using a multivariate t-test and 2x2 Repeated Measures Multivariate statistics. However, there were multiple limitations in this research project.

This study considered only one internship program, which limits the generalizability of the results. LARSS is a national program. Although it is a strong internship program, based on national ranking (Vault, 2013), it is only one internship in a sea of many. What issues are unique to this program as compared to another high quality program? What differences might there have been if multiple internships had been evaluated within this study? Perhaps with more internships, the number of female participants would have expanded, enabling more reliable results.

Sampling issues resulted from the low number of women in the population and the low percentage of people completing the survey. A survey of a larger population of women is necessary in order to more accurately define the needs, interests, and experiences of women in engineering. The low number of women participating in the current study limited the statistical procedures that could be used and reduced the statistical power of the results, especially for the second research question. A larger sample would have allowed for a factor analysis of the skills, moving from the unit of analysis as individual skills to clusters of skills, increasing reliability. In engineering research, however, finding enough women engineers is a frequent problem, and one of the reasons that research such as this is often exploratory or qualitative in nature. Due in part to the timing of this study and in part to the lack of incentives for completion of the survey (Dillman, 2000), the survey completion rate was lower than desired; 34.7% of women and 41.6% of men completed the survey. Although this study was subject to barriers related to timing and lack of funds for incentives, future studies should be run during spring or early fall, not during the holiday season and should include some form of incentive. With a larger sample of women, the reliability of the results will greatly improve.

Finally, the current study did not operationally define terms such as 'computer skills' and 'oral communication' to ensure that they have similar meaning to all study participants, this adjustment could be done for future research. Computer skills to a computer software engineer will be very different than computer skills for a materials engineer which will further differ from an aerospace engineer. Oral communication could be interpreted by one intern as technical vocabulary and to another as comfort in speaking in front of a group. Operationalizing these terms will ensure that comparisons of participant responses are based on similar understandings of the terms.

Recommendations for future research

The first and most obvious recommendation for future research is to increase the number of women engineers participating in research studies in the hopes of more accurately defining the unique challenges for and needs of women in engineering programs. Making up only 20% of the engineering students (Yoder, 2012) and 11% of the engineering workforce (Fouad & Singh, 2011), attaining higher actual numbers of female participants in a study requires a much higher percentage of all the women in engineering. The fact that so few women are in the discipline contributes to the difficulty of obtaining sufficient research participation for studies such as this one. Finding ways to overcome barriers for women in engineering has been and will continue to be a concern and focus of research.

Next steps to this study would include follow-up interviews with multiple participants, both female and male, to identify some of the experiences each gender had in the internship and begin to assess the similarities and differences of their experiences. Did men and women have different mentoring experiences? Did they have different expectations of the internship? Did they have different roles in the research project? Did they have similar expectations going into the internship and were these expectations met? Interviews should also include a discussion of some of the definitions previously mentioned to determine how participants defined these terms. For instance, how did respondents define computer skills? Were they basing their responses on a definition related to basic skills or programming skills? The answers to these questions will provide valuable insight on many of the questions asked throughout the current study.

Quantitatively, future research on skills should clearly define each skill with examples and a definition to ensure that computer programming skills are not being considered in the same question as typing skills. Expanding the study to include multiple internship programs and different institutions would allow for the use of Hierarchical Linear Modeling, which would significantly improve the breadth and depth of information available on women in engineering internships.

One of the outcomes of an exploratory study is a wide array of questions that emerge given initial findings. Such is the result of this study. There are many possible areas of future study related to women in engineering and their experience of an internship. Below are just a few that one could explore on this subject:

- Each sector of engineering (academia, industry, and government) is unique, with different needs and expectations. Looking at partnerships between higher education and industry/government – do the needs of women change depending on the sector they intern in? Does an internship in government prepare her adequately for a career in industry?
- Comparing 21st Century skills to ABET skills, do ABET skills increase the success of women or decrease their success? Do these skills better prepare women for working in an engineering field than the 21st Century skills? Although there are many similarities between the skill sets, are there different approaches used in teaching each set? If so, how do these differences affect women?

- Do authentic learning opportunities in the first two years of an engineering degree program increase the likelihood of persistence into an engineering field? Does it matter if these opportunities are in academia or in industry or government? Are there differences in persistence between those who intern in their first two years and those who intern in their last two years?
- Does the gender of the mentor have an impact on the persistence of intern, male or female? Is gender matching beneficial in mentoring or does it reinforce gendered stereotyping for both women and men? Evidence on the gender of professors is inconclusive, but what about the experience of women with female mentors? Is it an advantage or a disadvantage?
- Should future research break out interns based on their role in engineering (management versus technical position) or the type of engineering they are engaged in? Civil and aeronautical engineering are very different with different skill sets needed (civil lots of human interaction, aerospace less, for example). Are those in management relying on different skills than those in the more technical positions? If so, how should internships be designed to ensure adequate preparation in both types of skills?

Conclusions

The focus of this study was on determining the ideal elements of an engineering internship for women by first considering whether or not women and men perceive the internship in the same way. This question was analyzed through two questions: What elements of the internship are perceived by women as most important in preparing women for a profession in engineering as compared to those that are perceived by men as most important to men? And what skills are developed in the internship that support women's persistence into an engineering profession as compared to the skills that support men's persistence? These questions were answered based on results from a survey of the NASA LARSS internship program.

The answer to the first question was that men consider the research project and mentoring to be more important than women consider them. No other statistical differences were found between men and women. Looking only at the means and standard error for women, women considered the research project, networking, and the mentor as the most important elements of the internship. However, this does not speak to any differences between men and women. Due to the small and uneven sample sizes (women, 40; men, 122), further analysis of this question was not feasible. Nevertheless, the significant differences between men and women's ratings for the research project and mentoring require a rejection of the null hypothesis. There is a difference in how women and men perceive the benefits of the professional internship for members of their own gender. Further research is needed to define the exact nature of these differences, and such research will require a larger sample of women.

The second question focused on the skills developed in the internship and the effectiveness of the internship to prepare the intern for those skills in the field. Only those participants who were working in an engineering field at the time of the study were included in this question (women, 27; men, 82). Twenty skills were evaluated based on their importance in the engineering field and the effectiveness of the internship to prepare the intern in each skill. No gender differences were found. The only differences found were between the importance of the skill to the job and the effectiveness of the internship to prepare the intern for that skill. Significance was found for 17 of the 20 skills. Caution was advised in the interpretation of these results due to the low number of female respondents. Based on these results, there are no differences between the skills that support women and men's persistence into an engineering field. The null is rejected based on the results of this analysis. Future research should continue to examine this question; however, to determine if, with a larger, and preferably equal, sample size, the results will be different.

Taken together, the results of this analysis suggest that there are gender differences between how men and women perceive the benefits of the professional internship for members of their own gender group. This finding is based on the statistical differences for mentoring and research project in the first analysis.

This exploratory study contributes to the knowledge base on the perceptions of women and men of the benefits of the professional internship by providing evidence of a statistically significant difference between the level of importance women and men assign to mentoring and the research project. As a result of this finding, higher education engineering programs ought to consider the differing perceptions of women and men as they develop internship programs for their students. Faculty leaders and internship administrators ought to carefully consider what types of business, industry, and government agencies they partner with for internships, particularly as related to mentorship models and the assignment of and oversight for research projects. Internships within the higher education institution should receive the same scrutiny as outside partners to ensure that students are receiving the guidance and support they need.

Engineering programs need to consider carefully what types of mentoring students will receive, encouraging training for mentors on the psychosocial aspects of mentoring as well as the technical (Burke & Mattis, 2007; Chesler & Chesler, 2002). In addition, institutions should consider mentoring teams, not just individual mentors (Chesler & Chesler, 2002). Teams could consist of peers, academic mentors, and field mentors or a team of mentors in the field could be encouraged to mentor a group of interns. By creating teams to oversee multiple mentees, the likelihood of women having access to female engineers is increased. Such alternatives to the standard mentor-mentee relationship should be considered as internships are developed to ensure the maximum amount of support to women as well as men.

Research projects should be developed in collaboration with the university whenever possible to ensure that the student is engaged in a research project that will support her development in the field. Based on the recommendations of NACE (2012), it is unacceptable to assign an intern menial tasks. This requirement is a positive step; however, without adequate direction, an intern may not succeed in her project. Successful research projects were referenced in the comments of multiple women for whom the experience changed or confirmed the direction of their future careers. Some were able to choose their own projects, others were able to work on projects that tied to their academic experiences. Many of the women cited the benefits of and quality of their research experience. However, men ranked the research project significantly higher than women. This suggests that while the experience was positive for many of the participants, there is room for improvement. Just what aspects of the research project should be improved requires further study. However, based on the input from the respondents, independence, working with others, and the opportunity to explore an area of interest are all aspects of the research project that are valued by the women participating in the current study.

In summary, this research found that there were differences in perception of the internship based on gender. Yet, men and women did not have differences in their view of the value of the internship relative to the skills needed on the job. Both groups, however, did feel that the internship did not prepare them to the level demanded in the field across a host of skills. Those participating in the LARSS internship reported greater persistence into the field of engineering than the general engineering population. Thus, this research shows that the LARSS internship is having a positive impact on women's persistence into engineering careers and challenges presumed assumptions of differences in engineering based solely on gender. Overcoming the gendered dichotomies common to the field is critical to the diversification of engineering. Deconstructing the questions asked about women in engineering provides a critical first step into addressing challenges and barriers facing these women.

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Appendix A

Final Survey

LARSS Longitudinal 1991-1995

Q1 This survey relates to your experiences before, during and after the Langley Aerospace Research Student Scholars (LARSS) internship and your perceptions of the impact of the program on your academic and career decisions. The survey should take approximately 20-25 minutes to complete. In addition, at the end of the survey you will have the opportunity to indicate if you are willing to participate in an optional, in-depth phone interview. Of those who volunteer, we will select several for future follow-up. Your responses will remain confidential. No identifiable information (e.g. email address and name) will be included in the data analysis. You will not be identified by name or in any manner that will reveal your identity. Information collected will be shared with NASA to help guide students from academia to the workforce. You will have the opportunity to request a copy of the results at the end of the survey. Presentations and manuscripts may result from the analysis of these data. Your participation is voluntary and can be withdrawn at any time. Your responses are saved automatically, so if you need to stop in the middle of the survey and come back to it, you will not lose any information. Finally, back arrows allow you to return to a previous question without deleting other responses. Please check the "yes" box if you are willing to participate in the survey.

- ○ Yes (1)
- ○ No (2)

If No Is Selected, Then Skip To End of Survey

Q2 I. Education and Professional Experience Have you completed your undergraduate degree?

- ○ Yes (1)
- ○ No (2)

If No Is Selected, Then Skip To End of Block

Q3 Please tell us about your academic career. Begin with your most recent degree.

Degree Type	Year anticipated or received	Major/Discipline/Academic Field

Q4 Are you currently employed in a STEM-related job? STEM-related fields include those in science, technology, engineering, and mathematics as well as education in these fields.

- Yes (1)
- No (2)
- Not sure. What exactly is a STEM-related job? (3)

If Yes Is Selected, Then Skip To Which one of the following best descr...

Q5 STEM Occupations according to the U.S. Department of Commerce, Economics and Statistics Administration. For our purposes, education in any of these fields is considered STEM-related. Computer and Math Occupations Computer scientists and systems analysts Network systems and data communications analysts Computer programmers Mathematicians Computer software engineers Operations research analysts Computer support specialists Statisticians Database administrators Network and computer systems administrators Miscellaneous mathematical science occupations Engineering and surveying occupations Surveyors, cartographers, and photogrammetrists Materials engineers Aerospace engineers Mechanical engineers Agricultural engineers Mining and geological engineers, including mining safety engineers Biomedical engineers Nuclear engineers Chemical engineers Petroleum engineers Civil engineers Engineers, all other Computer hardware engineers Drafters Electrical and electronic engineers Engineering technicians, except drafters Environmental engineers Surveying and mapping technicians Industrial engineers, including health and safety Sales engineers Marine engineers and naval architects Physical and life sciences occupations Agricultural and food scientists Physical scientists, all other Biological scientists Agricultural and food science technicians Conservation scientists and foresters Biological technicians Medical scientists Chemical technicians Astronomers and physicists Geological and petroleum technicians Atmospheric and space scientists Nuclear technicians Chemists and materials scientists Other life, physical, and social science technicians Environmental scientists and

geoscientists STEM managerial occupations Computer and information systems managers Natural sciences managers Engineering managers
Education Education in any of the above areas is considered STEM-related for the purposes of this study. Adapted from: STEM: Good Jobs Now and for the Future, 2011

Q6 Are you currently employed in a STEM-related job? STEM-related fields include those in science, technology, engineering, and mathematics as well as education in these fields.

- ❍ Yes (1)
- ❍ No (2)

If Yes Is Selected, Then Skip To Which one of the following best descr...

Q7 Why did you leave the STEM field?

- ❑ Still in school and have not entered the field yet (1)
- ❑ Could not find a position in a STEM field (2)
- ❑ Changes in personal life/situation (e.g., health, family needs, etc) (3)
- ❑ Challenges with work-life balance (4)
- ❑ Changes in the economy/markets (5)
- ❑ Planning/starting my own business (6)
- ❑ Work environment/company culture (7)
- ❑ Dissatisfaction with the job (8)
- ❑ Lack of empowerment/opportunity for advancement (9)
- ❑ Other, please specify: (10) ____________________

If Still in school and have no... Is Selected, Then Skip To Have you ever served as a mentor?

Q8 Which of the following best describes your current place of primary employment?

- ❍ NASA civil servant (1)
- ❍ NASA contractor (2)
- ❍ Department of Defense (DoD) including military (3)
- ❍ Department of Defense (DoD) contractor (4)
- ❍ Federal government (except DoD and NASA) (5)
- ❍ State or local government, institution or agency (except education) (6)
- ❍ Self-employed in own business or professional practice (7)
- ❍ Higher education. Please specify area/department (8) ____________________
- ❍ Elementary or secondary education. Please specify area (English, history, etc.) (9) ____________________
- ❍ International organization in US (10)
- ❍ International organization outside the US (11)
- ❍ Private, for-profit business/industry (12)
- ❍ Private or non-profit business/industry (except education and international organizations) (13)
- ❍ Student - full or part time (14)
- ❍ Retired (15)
- ❍ Currently unemployed (16)
- ❍ Other, please specify (17) ____________________

Answer If Are you currently employed in a STEM-related job? STEM st... Yes Is Selected

Q9 Which one of the following best describes your current employer/place of primary employment?

- ❍ NASA civil servant (1)
- ❍ NASA contractor (2)
- ❍ Department of Defense (DoD) active military (3)
- ❍ Department of Defense (DoD) civil servant (4)
- ❍ Department of Defense (DoD) contractor (5)
- ❍ Federal government (except DoD and NASA) (6)
- ❍ State or local government, institution or agency (other than education) (7)
- ❍ Self-employed in own business or professional practice (8)
- ❍ Higher education. Please specify discipline/department (9) ____________________
- ❍ Elementary or secondary education. Please specify discipline (science, math, etc.) (10) ____________________
- ❍ International organization in US (11)
- ❍ International organization outside the US (12)
- ❍ Private, for-profit business/industry (13)

- ❍ Private or not-for-profit business/industry (except education and international organizations) (14)
- ❍ Other, please specify (15) ____________________

Q10 Please list in reverse chronological order the positions you have held for 6 months or longer since leaving LARSS (More lines are available on the next screen). Note: there are 5 parts to this question - please scroll to the right.

Approximately how long were you in this position?	Geographically, where was this position located (state or continent)?	What kind of work did you do in your principal occupation?	In what sector do/did you work?	Was the position full time (FT) or part time (PT)?

(Table Truncated to 63 Columns)

Q11 Do you need more lines for your previous occupations?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To Have you ever served as a mentor?

Q12 Please list in reverse chronological order the positions you have held for 6 months or longer since leaving LARSS. Note: there are 5 parts to this question - please scroll to the right.

Approximately how long were you in this position?	Geographically, where was this position located (state or continent)?	What was your principal occupation?	In what sector did you work?	Was the position full time (FT) or part time (PT)?

(Table Truncated to 63 Columns)

Q13 Have you ever served as a mentor?

	Yes (1)	No (2)
Professional capacity (e.g. intern, new employee) (1)	❍	❍
Non-professional (e.g., Big Brother, Big Sister, tutoring) (2)	❍	❍

Q14 II. Your LARSS Internship(s) Participants find out about the LARSS program from a variety of sources. How did you learn about the LARSS program? Please enter "1" beside your first source of information, "2" beside your second, and so on for up to five (5) sources.

______ A relative associated with NASA (1)
______ A relative not associated with NASA (2)
______ A friend associated with NASA (3)
______ A friend or classmate (not associated with NASA) (4)
______ A NASA employee (5)
______ A former LARSS intern (6)
______ A professor (7)
______ Career planning office at my school (8)
______ Listing of internships (9)
______ A program briefing (including webinar or video/teleconference) (10)
______ Career or job fair (11)
______ A previous NASA experience (12)
______ Internet search (13)
______ LARSS program website (14)
______ LARSS program brochure (15)
______ Facebook or other social networking site (16)
______ Other, please specify (17)
______ Don't recall (18)

Q15 How many non-LARSS internships have you participated in?

- ❍ 0 internships (1)
- ❍ 1 internship (2)
- ❍ 2 internships (3)
- ❍ 3 internships (4)
- ❍ 4 internships (5)
- ❍ 5 internships (6)
- ❍ More than 5 internships (7)

If 1 internship Is Selected, Then Skip To Would you recommend the LARSS interns...

Q16 How would you rate the LARSS internship compared to your other internship(s) in preparing you for the workforce? LARSS was...

- ❍ Not as beneficial (1)
- ❍ Equally beneficial (2)
- ❍ More beneficial (3)
- ❍ I did not participate in an internship outside of LARSS. (4)

Q17 Would you recommend the LARSS internship to a student interested in or actively pursuing a STEM career?

- ❍ Yes (1)
- ❍ No (2)

Q18 How satisfied are you with each of the following?

	1 - Very dissatisfied (1)	2 (2)	3 (3)	4 (4)	5 - Very satisfied (5)
Your LARSS summer internship(s)? (1)	❍	❍	❍	❍	❍
Your mentor during your most recent LARSS internship experience? (2)	❍	❍	❍	❍	❍
Your research team's collaborative efforts during your most recent LARSS internship experience? (3)	❍	❍	❍	❍	❍

Q19 Please indicate the importance of the following elements of LARSS in preparing you for your chosen profession/career.

	1 - not important (1)	2 (2)	3 (3)	4 (4)	5 - very important (5)	N/A (6)
Mentoring by experts in a specific field (1)	O	O	O	O	O	O
Participation in a research project (2)	O	O	O	O	O	O
Networking opportunities (3)	O	O	O	O	O	O
LARSS lecture series (4)	O	O	O	O	O	O
LARSS career enhancement seminars (5)	O	O	O	O	O	O
Technical report writing/publication based on LARSS project (6)	O	O	O	O	O	O
Poster session/presentation based on a LARSS project (7)	O	O	O	O	O	O
On center tours (8)	O	O	O	O	O	O
Field trips to other NASA centers (9)	O	O	O	O	O	O

Q20 Please indicate your level of agreement with the following statements about your LARSS internship(s).

	1 - strongly disagree (1)	2 (2)	3 (3)	4 (4)	5 - strongly agree (5)	N/A (6)
The support from the program staff was excellent (1)	❍	❍	❍	❍	❍	❍
The research you did was challenging (2)	❍	❍	❍	❍	❍	❍
Opportunities to network were available (3)	❍	❍	❍	❍	❍	❍
The lectures were beneficial (4)	❍	❍	❍	❍	❍	❍
The career enhancement/ etiquette seminars were beneficial (5)	❍	❍	❍	❍	❍	❍
Writing your technical report, based on your LARSS research was a valuable learning experience (6)	❍	❍	❍	❍	❍	❍
The poster session/ presentation based on your LARSS	❍	❍	❍	❍	❍	❍

research was a positive experience (7)						
The on center tours were informative (8)	❍	❍	❍	❍	❍	❍
The field trip(s) to other NASA centers were informative (9)	❍	❍	❍	❍	❍	❍

Q21 How important was/were your LARSS internship(s) in helping you determine your career goals?

- ❍ 1 - not at all important (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 - critically important (5)
- ❍ I had clear career goals before I participated in LARSS. (6)

Answer If 'Why did you leave the STEM field?' 'Still in school and have not entered the field yet' Is Not Selected

Q22 How important was/were your LARSS internship(s) in helping you compete successfully in the job market?

- ❍ 1 - not at all important (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 - critically important (5)
- ❍ Not sure (6)

Q23 Please indicate the importance of the following workforce skills in your current job and then indicate the effectiveness of your LARSS internship(s) in developing these workplace skills. If you are currently unemployed, complete the second column only.

	How important is the skill to your current job?					How effective was your LARSS internship in developing these skills?				
	Not important (1)	Somewhat important (2)	Important (3)	Very important (4)	Extremely important (5)	Not effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	Extremely effective (5)
Thinking critically (1)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Exercising judgment (2)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Making sound decisions (3)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Solving problems (4)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Creating and/or innovating (5)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

Time management skills (6)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Appreciation for diversity (7)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Demonstrating professional behavior (8)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Working independently (9)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Leadership skills (10)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Continuous learning (11)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

Q24 Please indicate the importance of the following workforce skills in your current job and then indicate the effectiveness of your LARSS internship(s) in developing these workplace skills. If you are currently unemployed, complete the second column only.

	How important is the skill to your job?					How effective was the LARSS internship in developing the skill?				
	Not important (1)	Somewhat important (2)	Important (3)	Very important (4)	Extremely important (5)	Not effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	Extremely effective (5)
Communicating in writing (1)	O	O	O	O	O	O	O	O	O	O
Communicating orally/verbally (2)	O	O	O	O	O	O	O	O	O	O
Collaborating/working with others (3)	O	O	O	O	O	O	O	O	O	O
Adapting to change (4)	O	O	O	O	O	O	O	O	O	O
Working as part of a research team (5)	O	O	O	O	O	O	O	O	O	O
Thinking analytically (6)	O	O	O	O	O	O	O	O	O	O
Computational skills (7)	O	O	O	O	O	O	O	O	O	O
Computer skills (8)	O	O	O	O	O	O	O	O	O	O
Technical skills (9)	O	O	O	O	O	O	O	O	O	O

Q25 III. Interest in STEM (science, technology, engineering, or mathematics) At about what age (e.g., age 8, 12, 16) did you become interested in a STEM area?

Q26 When did you decide to pursue a career in a STEM (science, technology, engineering or mathematics) field?

- ❍ Before elementary school (1)
- ❍ Elementary school (2)
- ❍ Middle school (3)
- ❍ High school (4)
- ❍ After applying but before starting college (5)
- ❍ After entering college (Please specify freshman, sophomore, junior, or senior year) (6) ____________________
- ❍ After receiving my undergraduate degree (7)
- ❍ Other (8)

Q27 Please indicate the level of influence each of the following people has had on your decision to pursue a STEM field. If the person had a NEGATIVE influence, select 9, then rate the significance of that influence on the scale of 1-5. NOTE: No influence means that person was present, but did not influence your decision. N/A means that you had no experience with this person.

	1 - no influence (1)	2 (2)	3 (3)	4 (4)	5 - significant influence (5)	9 - negative influence (6)	N/A (7)
Same gender friend with similar interests (1)	❑	❑	❑	❑	❑	❑	❑
Different gender friend with similar interests (2)	❑	❑	❑	❑	❑	❑	❑
Family member in a STEM field. (Please specify the relationship) (3)	❑	❑	❑	❑	❑	❑	❑
NASA speaker (4)	❑	❑	❑	❑	❑	❑	❑
Teacher in elementary school who encouraged me to think about a STEM field (5)	❑	❑	❑	❑	❑	❑	❑
Teacher in middle school who encouraged me to think about a STEM field (6)	❑	❑	❑	❑	❑	❑	❑
Teacher in high school who encouraged me to think about a STEM field (7)	❑	❑	❑	❑	❑	❑	❑
Someone at my school knowledgeable	❑	❑	❑	❑	❑	❑	❑

about STEM career options (Please specify the position e.g., guidance counselor, career counselor) (8)							
College/university STEM faculty (9)	❑	❑	❑	❑	❑	❑	❑
Mentor who encouraged me to think about a STEM field (10)	❑	❑	❑	❑	❑	❑	❑
Same gender role model with STEM interests (11)	❑	❑	❑	❑	❑	❑	❑

Q28 Please indicate the level of influence of each of the following on your decision to pursue a STEM field. If you feel the area listed had a NEGATIVE influence, select 9, then rate the significance of that influence on the scale of 1-5. NOTE: No influence means that you had the experience, but it did not influence your decision. N/A means you did not have that experience.

	1 - no influence (1)	2 (2)	3 (3)	4 (4)	5 - significant influence (5)	9 - negative influence (6)	N/A (7)
My personal interests (1)	❑	❑	❑	❑	❑	❑	❑
Engineering classes in middle or high school (2)	❑	❑	❑	❑	❑	❑	❑
Science classes in middle or high school (3)	❑	❑	❑	❑	❑	❑	❑
Technology classes in middle or high school (4)	❑	❑	❑	❑	❑	❑	❑
Math classes in middle or high school (5)	❑	❑	❑	❑	❑	❑	❑
Classes (not those listed above) in middle or high school (6)	❑	❑	❑	❑	❑	❑	❑
After school activity/club focusing on STEM (7)	❑	❑	❑	❑	❑	❑	❑
Hands on experience during school (8)	❑	❑	❑	❑	❑	❑	❑
Hands on experience outside of school (9)	❑	❑	❑	❑	❑	❑	❑
Visit to NASA (10)	❑	❑	❑	❑	❑	❑	❑
Air and Space	❑	❑	❑	❑	❑	❑	❑

Museum (e.g. Smithsonian Air and Space) (11)							
Other exhibits/museums (e.g. STEM related children's museum) (12)	☐	☐	☐	☐	☐	☐	☐
NASA event (13)	☐	☐	☐	☐	☐	☐	☐
NASA camp (14)	☐	☐	☐	☐	☐	☐	☐
Television program/movie (15)	☐	☐	☐	☐	☐	☐	☐
Membership in STEM related organization (16)	☐	☐	☐	☐	☐	☐	☐
Competitive academic experience (17)	☐	☐	☐	☐	☐	☐	☐
On-campus research opportunity (18)	☐	☐	☐	☐	☐	☐	☐
Career fairs (19)	☐	☐	☐	☐	☐	☐	☐
Summer job, internship or co-op (20)	☐	☐	☐	☐	☐	☐	☐

Q29 Please provide additional comments to help us better understand your experience before, in, or after LARSS.

Q30 If you are willing, please provide the following. Note: there are 6 parts to this question, please scroll to the right.

Gender	Ethnicity	Classification in school during last LARSS internship	Year of last LARSS internship	Name of mentor in your last LARSS internship	Are/Were you a first generation college student (first generation of your family to attend college)?

Q31 Follow-up Information A limited number of participants may be selected to participate in a more in-depth telephone interview. May we contact you for this purpose?

- Yes (1)
- No (2)

If No Is Selected, Then Skip To You may request a...

Q32 What is the best number to reach you at and what are the most convenient time(s)? We will gladly work with your schedule.

Q33 You may request a copy of the study results by checking "Yes" and providing your preferred email or U.S.P.S. address below. Note: Upon completion, results of the study will also be available on the LARSS website for your convenience.

- ❍ Yes, my preferred address is below. (1) ____________________
- ❍ No (2)

Q34 IV. Your Life Now (optional) In the past five years have you participated in any of the following activities? (Check all that apply.)

- ❑ Visited NASA (NASA Langley or any other NASA center) (1)
- ❑ Attended a reunion with former LARSS interns/mentors (2)
- ❑ Met with former LARSS colleagues/mentors at conferences or meetings (3)
- ❑ Contacted former LARSS colleagues (4)
- ❑ Contacted former LARSS mentor(s) (5)
- ❑ None of the above (6)

Q35 In the past twelve months, have you been involved in any of these activities (check all that apply)?

- ❑ Served on a committee for a professional/technical society or academic association related to your career choice (1)
- ❑ Served as an officer for a professional or academic association associated with your career choice (2)
- ❑ Attended a professional conference (3)
- ❑ Presented at a professional conference (4)
- ❑ Mentored a student intern (5)
- ❑ Served on a local government board or commission (6)
- ❑ Volunteered for a group/club that promotes STEM careers (7)
- ❑ Run for an elected office (8)

Appendix B

IRB Approval

This is to notify you on behalf of the Education Internal Review Committee (EDIRC) that protocol EDIRC-2012-08-02-7992-kmbrus titled The LARSS Internship Longitudinal Study has been EXEMPTED from formal review because it falls under the following category(ies) defined by DHHS Federal Regulations: 45CFR46.101.b.2.

Work on this protocol may begin on 2012-08-08 and must be discontinued on 2013-08-08.

Should there be any changes to this protocol, please submit these changes to the committee for determination of continuing exemption using the Protocol and Compliance Management application (https://compliance.wm.edu).

Please add the following statement to the footer of all consent forms, cover letters, etc.: THIS PROJECT WAS FOUND TO COMPLY WITH APPROPRIATE ETHICAL STANDARDS AND WAS EXEMPTED FROM THE NEED FOR FORMAL REVIEW BY THE COLLEGE OF WILLIAM AND MARY PROTECTION OF HUMAN SUBJECTS COMMITTEE (Phone 757-221-3966) ON 2012-08-08 AND EXPIRES ON 2013-08-08.

You are required to notify Dr. Ward, chair of the EDIRC, at 757-221-2358 (EDIRC-L@wm.edu) and Dr. Kirkpatrick, Chair of the PHSC at 757-221-3997 (phsc-chair@wm.edu) if any issues arise during this study.

Good luck with your study.

Appendix C

Email with Link

Survey of FORMER LARSS SUMMER INTERNS

Thank you for participating in this survey of former LARSS summer interns. As many of you know, I'm Kimberly Brush, a doctoral student at the College of William and Mary. I have been working with Dr. Thomas Pinelli of the University Affairs Office at NASA Langley to plan and implement a longitudinal study of former LARSS summer interns. With the current emphasis on developing the nation's STEM pipeline and the NASA workforce, we are trying to determine the relationship between the LARSS experience and the training and development of engineers and scientists.

The survey should take between 20 and 30 minutes to complete and your responses will remain confidential. Your participation represents a valuable contribution to this study and our understanding of STEM.

The survey is divided into three parts:

- Your Education and Career
- Your LARSS internship(s)
- Your interest in STEM

The term "STEM" as used in this survey stands for science, technology, engineering, and mathematics. STEM employment can include computer, mathematics, engineering, physical and life sciences, or STEM management occupations.

If you experience technical problems while taking the survey, or have any questions, please contact me at Kimberly.m.brush@nasa.gov or kmbrus@email.wm.edu or call 757-864-6454 (work) or 757-784-3741 (cell).

Thank you again for your time and commitment to the LARSS program.

Please click on the link below to be directed to the survey.

Kimberly Brush
Co-op Student
NASA Langley
Office of Education
757-864-6454 (w)
757-784-3741 (c)

Appendix D

Survey and Research Question Crosswalk

Survey question number with subquestions	Developing the context (descriptives)	Research Question 1: What elements of the internship are perceived as most important in preparing women for a profession in engineering as compared to men?	Research Question 2: What skills are developed in the internship that support women's persistence into an engineering profession as compared to men?
1			
2	x		
3	x		
4			
5	x		
6	x		
7			
8	x		
9	x		
10			
11			
12(a-c)			
13(a-i)		x	
14(a-i)			
15	x		
16	x		
17(a-k)			x
18(a-k)			x
19(a-i)			x
20(a-i)			x
21			
22			
23			
24			
25			
26			
27			
28			
29			
30(a-f)	x		
31			
32			

33			
34			
35			

Appendix E

Crosswalks

Table E1

Variables and Research Questions Crosswalk

Survey Question Number	Survey Questions/variables	Research Question 1: What elements of the internship are perceived as most important in preparing women for a profession in engineering as compared to men?	Research Question 2: What skills are developed in the internship that support women's persistence into an engineering profession as compared to men?
19	Indicate the importance of the following elements of LARSS in preparing you for an engineering profession.		
	mentoring by experts in a specific field	x	
	participation in a research project	x	
	networking opportunities	x	
	LARSS lecture series*	x	
	LARSS career enhancement seminars*	x	
	technical report writing/publication	x	
	poster session/ presentation based on a LARSS project	x	
	on center tours	x	
	field trips to other NASA centers	x	
23	Please indicate the importance of the following workforce skills in your current job?		
	thinking critically		x

	exercising judgment		x
	making sound decisions		x
	solving problems		x
	creating and/or innovating		x
	time management skills		x
	appreciation for diversity		x
	demonstrating professional behavior		x
	working independently		x
	leadership skills		x
	continuous learning		x
24	Please indicate the effectiveness of your LARSS internship(s) in developing these workplace skills.		
	thinking critically		x
	exercising judgment		x
	making sound decisions		x
	solving problems		x
	creating and/or innovating		x
	time management skills		x
	appreciation for diversity		x
	demonstrating professional behavior		x
	working independently		x
	leadership skills		x
	continuous learning		x
25	Please indicate the importance of the following workforce skills in your current job?		
	communicating in writing		x
	communicating orally/verbally		x
	collaborating/working		x

	with others		
	adapting to change		x
	working as part of a research team		x
	thinking analytically		x
	computational skills		x
	computer skills		x
	technical skills		x
26	Please indicate the effectiveness of your LARSS internship(s) in developing these workplace skills.		
	communicating in writing		x
	communicating orally/verbally		x
	collaborating/working with others		x
	adapting to change		x
	working as part of a research team		x
	thinking analytically		x
	computational skills		x
	computer skills		x
	technical skills		x

Table E2

Statistics Crosswalk

Research Questions	Statistics	Statistical References	Supporting Research
Demographics	Descriptive Statistics: Mean, Standard deviation; kurtosis; skew	Creswell, 2012; Fraenkel & Wallen, 2006; Gall, Gall, & Borg, 2007; Kiess & Green, 2010	
Research Question 1: What elements of the internship are perceived as most important in preparing women for a profession in engineering as compared to men?	Independent SampleT-Tests	Fraenkel & Wallen, 2006; Gall, Gall, & Borg, 2007; Kiess & Green, 2010	Dohn et al., 2005; Felder et al., 1995; Kardash, 2000; Stevens et al., 2005; Wright et al., 2007; Zeldin & Pajares, 2000
Research Question 2: What skills are developed in the internship that support women's persistence into an engineering profession as compared to men?	Paired T-Tests Independent Sample T-Test	Fraenkel & Wallen, 2006; Gall, Gall, & Borg, 2007; Kiess & Green, 2010	21st Century Workforce Commission, 2000;Haag et al., 2006; Hall et al., in review; Moulton & Lowe, 2005; P-21, 2011; Pinelli & Hall, 2012; Ruiz et al., 1999; Stevens et al., 2005